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The Relationship Between Snacking Habits and Impulsivity Levels in Adolescents

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The relationship between snacking habits and impulsivity levels of adolescents

A Thesis Presented

By

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Abstract

Adolescent obesity is an important public health issue, and one important factor that contributes to the problem is overeating, eating more than required for homeostasis. Appetitive behaviors such as overeating may in part be the result of poor control of impulsive behavior. This study investigated the relationship between impulsivity factors and snacking habits. The Youth/Adolescent Food Frequency Questionnaire (YAQ) and the Barratt Impulsivity Scale (BIS) were completed by 198 Southern California high school students (56% female; age $M=15.8$, $SD=0.9$). Four subscales were calculated from responses on the YAQ and included the frequency of consuming sweetened drinks, sweet snacks, salty snacks, and fresh fruits. Multiple regression was used to determine the association of the YAQ subscales with the six first-order impulsivity factors in the BIS after adjusting for age, gender, and SES (mother and father education). Self-control impulsivity was positively associated with salty snack consumption. Both sweet snacks and drinks had a positive correlation with cognitive complexity. Finally, perseverance had a positive association with sweet snacks. Fruit consumption had no association with impulsivity levels. This is the first study of which we are aware that examined the association between snacking behaviors and the first-order factors for impulsivity in the BIS. It is beneficial to understand the processes behind snacking decisions so we can intervene to help adolescents make better food choices. Snacking is likely to be under the control of the adolescent compared, for example, to meals prepared at home by a parent or guardian. As a result, targeting snacking habits with interventions among adolescents may be an effective approach to reducing obesity.

I. Introduction

The obesity epidemic is becoming progressively worse, especially for adolescents. The rate of adolescent obesity is at an all time high of just over 17% (Ogden et al., 2006). Snack consumption has been found to have a positive association with overweight status (Nicklas, Yang, Baranowski, Zakeri, Berenson, 2003). The two foremost snacking contributors are desserts and salty snacks (Piernas and Popkin, 2010), both of which are considered palatable foods and are harder to resist eating than less fatty or sugary foods (Kenny, 2011). Adolescents are consuming more snacks and sugar sweetened beverages than they did 30 years ago (Piernas and Popkin, 2010). Researchers have found positive associations with soft drink consumption and obesity (Vartanian, Schwartz, Brownell, 2007).

The purpose of this study was to examine the association between impulsivity levels and snacking habits. Snack foods measured in this study consisted of sugar-sweetened drinks, sweet snacks, and salty snacks, all of which have been found to have an association with weight gain (Carels et al., 2001; Centers for Disease Control and Prevention, 2011; V. S. Malik et al., 2010; Piernas and Popkin, 2011; Vartanian et al., 2007). I hypothesized that participants with higher levels of specific factors of impulsivity including the first order factors of cognitive complexity and self-control (both falling under Non-planning Impulsiveness) are more likely to eat more snacks and drink more sweetened drinks due to a lack of forethought of future consequences. Further, I hypothesized that the participants with the factors of motor and perseverance (the motor impulsivity factors) are also more likely to snack and drink

sweetened drinks because they tend to act without thinking, and thus would be less likely to stop and consider if they are truly hungry. Conversely, I hypothesized that there would be no correlation between impulsivity and likeliness to consume fruit.

II. Background

Obesity Prevalence

Obesity is a significant public health problem—in the United States, 300,000 deaths a year are due to obesity related health issues (Allison et al., 2009). Obesity rates are increasing rapidly, especially in adolescents; adolescent obesity has tripled since 1980 (CDC). As rates increase, it becomes more and more important to understand the neurological mechanisms contributing to the cause so that a solution can be created. Both short term and long term effects of adolescent obesity exist and are of concern. Short term, obese adolescents have a much higher risk for orthopedic, pulmonary, cardiovascular, neurological, and endocrinal health problems (Must and Strauss, 1999). Studies have shown that early in life obesity can result in premature mortality later in life (Must and Strauss, 1999). Indeed, as of 2009, obesity follows tobacco use in leading causes of preventable death (Allison et al., 2009).

The causes of obesity are multi-factorial; certain socioeconomics, genetic, personal, and behavioral factors have all been shown to be predictors (Haines et al., 2007). A behavior variable that is a known predictor of obesity is dietary intake. Dietary intake is a behavior that is especially important to examine because obesity is primarily a result of high dietary intake, more so than family history or physical activity (Goris and Westerteop, 2008). Much research has been done to investigate eating behavior. Rockett et al. (2005) developed the Youth/Adolescent Food

Frequency Questionnaire (YAQ) to measure eating habits of children and adolescents. The main purpose of the questionnaire is to assess the dietary tendencies of the participants in the study. The YAQ has been validated and proven to be accurate and reproducible (Rockett et al., 1997; Rockett et al., 1995).

Reward Mechanisms

Recent research has suggested that obesity shares a common reward pathway with alcohol and drug addiction (Kenny, 2011). The brain reward systems that are activated by palatable foods, those rich in fats and sugars, are similar to the systems that are activated by use of addictive drugs (Kenny, 2011). Feeding is influenced by two main systems, the hedonic system and the metabolic system (Lutter and Nestler, 2009). Palatable foods are consumed for hedonic reasons, oftentimes regardless of caloric need. Indeed, the hedonic pathways can take precedence over the metabolic pathways due to an enhanced desire to consume highly palatable foods (Lutter and Nestler, 2009). Palatable foods release dopamine into the nucleus accumbens, which ultimately increases motivation to consume more palatable foods (Nestler, 2001; Erlanson-Albertson, 2005). In comparison, drug consumption is mediated exclusively by the hedonic pathway (Volkow and Wise, 2005).

Studies performed on rats demonstrate the extent to which the consumption of palatable food can stimulate the reward system. In 2004, Cabanac and Johnson found that rats repeatedly exposed themselves to unfavorable conditions such as -15°C temperatures or shocks to the foot in order to obtain palatable foods, despite being well-fed. Erlanson-Albertson (2005) also found that palatable foods were often consumed despite an absence of hunger.

Reward pathways have decreased response in obese rats when compared to control rats (Geiger et al., 2009). This study found that regular food increased dopamine levels in the nucleus accumbens in control rats. However, standard food was not enough to increase the levels in obese rats that had extensive access to palatable foods in the past; rather, highly palatable foods were necessary to trigger the dopamine release. A regular increase in dopamine levels due to palatable food consumption is similar to that seen in cocaine usage (Kenny, 2011). In both palatable food and drug use, a neurological loss of control due to overconsumption results in habitual and potentially compulsive behaviors (Erlanson-Albertson, 2005; Everett and Robbins, 2006).

Impulsivity

Impulsivity is a personality trait that includes risk-taking, non-planning, and quick decision-making behaviors. It has been found to play a role in many appetitive behaviors, including drug addiction and obesity (Swann et al., 2004). There are multiple theories of impulsivity; a commonly accepted characterization came from Ernest Barratt from his self-report measure, the Barratt Impulsivity Scale (BIS) (Stanford et al., 2009). This scale breaks impulsivity into first and second order factors. The three second-order factors expose the aspects of inattention, non-planning, and motor impulsivity. These three factors are then further broken into six first-order factors include attention, motor, self-control, cognitive complexity, perseverance, and cognitive instability. The different factors support the idea that impulsivity is a multi-faceted construct.

Impulsivity has been studied extensively in neural disorders and substance abuse (Stanford et al., 2009). Many people with substance abuse problems have been found to be highly impulsive (Lane et al., 2007; Bond et al., 2004). In interest to this paper, a relationship between impulsive traits in adolescents and earlier and increased alcohol and drug consumption has been found (Verdejo-Garcia et al. 2009). This suggests the need for early recognition and intervention with adolescents who tend to have higher levels of impulsivity.

Some research has looked at the link between food consumption and impulsivity levels. Eating disinhibition has a positive correlation with attention and motor impulsivity (Lyke & Spinella, 2004). It has been shown that obese people tend to be more impulsive than non-obese people (Nederkoorn et al., 2009). This is likely related to the findings that those with higher levels of impulsivity are more prone to higher food intake (Guerrieri et al., 2009). Further, obese children were found to have less inhibitory control to be more sensitive to reward, such as palatable foods, than non-obese children (Neederkorn et al., 2006). Sensitivity to reward can lead to overeating, which ultimately results in weight gain.

III. Methods

Subjects

Participants were 198 high school students living in Southern California. Their ages ranged from 14 to 17 years with a mean of 15.9 years. They came from a variety of high schools, all with many Hispanic students as well as lower income students (see Table 1). This sample of participants was given preference due to a higher prevalence of obesity in this population (NHANES, 1999-2002). Females comprised

approximately 56% of the participants. Participants completed the survey on the weekend, outside of school. This study was reviewed and approved by the CGU institutional review board (IRB).

Measurements

A team of data collectors from Claremont Graduate University's School of Community and Global Health recruited and assessed the students as part of a larger research project (Obesity Related Behavioral Intervention Trials: ORBIT) funded by the National Heart Lung and Blood Institute. The team used a multi-level recruitment approach by accessing high schools, posting flyers, and contacting parents to recruit participants. Measurements were taken to determine snacking habits and impulsivity levels of the students. Students self-reported their gender, age, race/ethnicity, and socioeconomic status (SES). SES was evaluated based on parent education levels.

Table 1. Demographic information for the participants

<i>Variable</i>	<i>Analysis</i>	
	Mean	SD
Age	15.8	0.9
	N	%
Male	87	44
Female	111	56
	Mean	SD
Highest level of education of mother	3.52	1.51
	(completed high school)	
	N	%
Less than 8 th grade	12	6
Less than high school	24	12.1
Completed high school	33	16.7
Some college or job training	53	26.8
Completed college	24	12.1
Completed Graduate school	3	1.5
Unknown	39	19.7
	Mean	SD
Highest level of education of father	3.15	1.33
	(completed high school)	
	N	%
Less than 8 th grade	15	7.6
Less than high school	29	14.6
Completed high school	38	19.2
Some college or job training	26	13.1
Completed college	19	9.6
Completed Graduate school	5	2.5
Unknown	65	32.8

YAQ

The Youth/Adolescent Questionnaire (YAQ) was completed by the participants on mini-laptops provided by CGU. The YAQ has been validated and proven to be accurate and reproducible (Rockett et al., 1997; Rockett et al., 1995). The YAQ assessed dietary habits of the participants. Daily servings of fruit, sweet snack foods, salty snack foods, and sugar-sweetened beverages were examined. Frequency scores for sweetened drinks were calculated by the sum of sweetened drink item response options (low option and high option). Write in responses were recoded to match the specifications for analysis set by Harvard University. The same was done for sweet snacks and salty snacks categories.

BIS

The Barrett Impulsivity Scale (BIS) is a commonly used scale that measures impulsivity levels. It has demonstrated its validity and reproducibility (Spinella, 2007; Patton et al., 1995). The questionnaire has the participants answer 30 questions gauging impulsivity facets such as money spending, future orientation, planning, and cognitive stability. The questions were measured on a four-point Likert-type scale (1=never, 4=always). The items were then broken down into three second-order factors and six first-order factors. The six first-order impulsivity factors in the BIS included: (a) attention (not focusing on the task at hand; example item: “I am restless at the theater or lectures.”), (b) motor impulsiveness (acting on the spur of the

moment; example item: “I do things without thinking.”), (c) self-control (lack of planning or thinking carefully; example item: “I say things without thinking.”), (d) cognitive complexity (dislike of challenging mental tasks; example item: “I get easily bored when solving thought problems.”), (e) perseverance (an inconsistent life style; example item: “I change residences.”), and (f) cognitive instability (thought insertions and racing thoughts; example item: “I often have random thoughts when thinking.”). These were emphasized because they fell under the second-order factors of motor (acting on impulse) and non-planning (the tendency against planning for the future) (Stanford et al., 2009). The first-order factors are useful to define impulsiveness on a more specific level, supporting Barratt’s idea that impulsivity is multi-faceted.

Statistical analysis

Bivariate correlations between snacking habits and impulsivity factors were estimated using Statistical Package for the Social Sciences (SPSS 19) software package. Unless otherwise indicated, all effects reported as significant are $p < 0.01$. Regressions were used to look for potential confounding variables in age, gender, and SES. In these multiple regressions, the types of snack (sweet, salty, fruit, or sweetened beverage) were entered as dependent variables in separate regression models. Impulsivity levels were tested as independent variables separately with each type of snack for a total of 16 regression models (4 outcomes X 4 impulsivity factors). I did not have hypotheses for the effects of the attention impulsivity factors, attention and cognitive instability, and therefore, did not fit the regression models to the data. Age, gender, and SES were entered as covariates.

IV. Results

Six significant correlations were found between BIA first order factors and YAQ responses. Overall, fruit consumption has no statistically significant correlation with impulsivity while sweet or salty snacks and sweet drinks have a significant correlation with at least one sub-type of impulsivity (Tables 2 & 4). To determine whether the correlations between BIS first order factors and YAQ responses were truly significant, possible demographics variable confounders were tested. A preliminary analysis compared demographic variables of age, gender, father's education level, and mother's education level with the snacking categories. No significant correlations were found (Table 3). A multiple regression was run with adjustments for demographic covariates in their relationship to snack habits (Table 4).

While none of the regression coefficients for the demographic variables were found to be statistically significant, results differed between the multiple regression and the correlations for impulsivity levels. Specifically, self-control impulsivity had a correlation for both salty snacks and sweet drinks originally but showed a significant correlation ($b=0.276$, $p<.01$) only with salty snack consumption once adjusted. Motor impulsivity had a significant correlation with both sweet snacks ($b=0.161$, $p<.05$) and sweet drinks ($b=0.157$, $p<.05$). Sweet snacks ($b=0.434$, $p<.01$) and sweet drinks ($b=0.330$, $p<.01$) are both correlated with cognitive complexity impulsivity. A significant correlation ($b=0.181$, $p<.05$) was found between perseverance and sweet snack consumption once adjusted; unadjusted, there was a correlation with sweet drinks as well.

Table 2. Correlations between YAQ responses and BIS first order factors

	<i>Motor</i>	<i>Self Control</i>	<i>Cognitive Complexity</i>	<i>Perseverance</i>
Salty Snacks	0.107	0.224*	0.052	0.068
Sweet Snacks	0.161*	0.144	0.374**	0.185*
Sweet Drinks	0.176*	0.119*	0.314**	0.172*
Fruit	-0.095	0.010	0.000	-0.098

*p<.05, **p<.01

Table 3. Correlations between YAQ snacking categories and participant variables

	<i>Salty Snack</i>	<i>Sweet Snack</i>	<i>Sweet Drinks</i>	<i>Fruit</i>
Participant Age	0.039	-0.027	-0.044	0.106
Participant Gender	0.097	-0.042	-0.137	-0.064
Highest level of education of father	-0.114	-0.049	0.059	-0.068
Highest level of education of mother	-0.037	0.078	-0.050	-0.011

*p<.05, **p<.01

Table 4. Regression results adjusted for age, gender, and SES.

	<i>Motor</i>	<i>Self-Control</i>	<i>Cognitive Complexity</i>	<i>Perseverance</i>
Salty Snacks	0.148	0.276**	0.054	0.084
Sweet Snacks	0.161*	0.120	0.434**	0.181*
Sweet Drinks	0.157*	0.065	0.330**	0.117
Fruit	-0.111	-0.022	0.014	-0.104

Standardized b values. *p<.05, **p<.01

V. Discussion

We hypothesized that more adolescents with higher levels of non-planning and motor impulsivity would have bad snacking habits. Only certain aspects of impulsivity were found to have a correlation with snacking habits. The self-control and perseverance factors each had one snacking correlation, self-control with salty snacks and perseverance with sweet snacks (Table 4). The data reveals that cognitive complexity, a non-planning impulsivity, has the strongest relationship with snacking of all the impulsivity factors examined in that it had a positive association with both sweet snacks and sweetened beverages. This is likely because food expectancies are primarily based on short-term neural outcomes (Reid et al., 2005) and cognitive complexity impulsivity is the result of not thinking about future affects but concentrating on the now. Motor impulsivity also had positive relationships with sweet snacks and sweetened beverages. These relationships could be a result of acting

without thinking—adolescents may consume sweet snacks and beverages due to the fact that they are available rather than stop and think about if they are truly hungry.

Interestingly, more associations were observed for sweet snacks than salty snacks. This carries the implication that sweet snacking is more impulsive than salty snacking. This may be due to snack distribution; as of 2006, desserts were the chief contributor to snacking (Piernas and Popkin, 2010). However, salty snacks consumption has had the highest increase in all snack consumption in the past 30 years, making it the second leading snacking contributor (Piernas and Popkin, 2010). Thus, it is possible that salty snacks might become more closely associated with impulsivity if they continue their current trend and eventually overtake sweets as the main snack.

As anticipated, there was no correlation between fruit and impulsivity. Fruit consumption has many long-term benefits such as reduced risk for many heart and chronic diseases (Liu et al., 2000; Ford and Mokdad, 2001). Fruit, a healthy snack, has no association with impulsivity (Table 4). This could be a result of reward mechanisms. Unhealthy, palatable snacks stimulate the brain reward system more intensely than less fatty or sweet foods (Wang et al., 2004). The immediate rewards from these bad snacks can be linked to certain impulsivity factors because the factors demonstrate a lack of foresight that could dissuade one from eating the snack. Without the foresight, one is more likely to think just about the immediate reward and thus consume the unhealthy snack. Accordingly, there is no association between fruit consumption and impulsivity because fruit is not a high instant reward mechanism food.

Some research has been done in regards to adolescent impulsivity and eating. There is evidence that children who display loss of consciousness (LOC) eating habits have higher levels of impulsivity than healthy adolescents (Hartmann et al., 2011). However, such evidence is not conclusive and others (Goldschmidt et al., 2011; Hartmann et al., 2012) have found no significant caloric intake differences between LOC groups and control groups.

A strength of this study is it improves our ability to predict snacking habits. Bad snacking is often a predictor of obesity. The relationships found in this study expand the breadth of our knowledge of factors leading to obesity.

Some limitations need to be considered when interpreting the findings. This study did not take into account the amount of snack food intake. In follow-up studies, it would be worthwhile to assess the caloric amount of snacks and impulsivity. A limitation of this study is that the study relied on self-reporting, which may limit the validity of participant responses. Thus, it is possible that the participants underreported the bad snacks that they consumed. However, both the YAQ and the BIS have been tested for consistency and reproducibility (Rockett et al., 1997; Spinella, 2007).

While further replications of the present findings are needed, these results imply some relationship between impulsivity and snacking habits. It is important to realize that impulsivity does have some influence on snacking habits, especially because it has been shown that the total snack consumption has a positive association with being overweight (Nicklas et al., 2003). It is beneficial to understand the processes behind snacking decisions so we can intervene to help adolescents make

better food choices. Snacking is likely to be under the control of the adolescent compared, for example, to meals prepared at home by a parent or guardian. As a result, targeting snacking habits with interventions among adolescents may be an effective approach to reducing obesity.

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References

- Activity, Y. P. (2011). Beverage consumption among high school students --- United States, 2010. *MMWR. Morbidity and mortality weekly report*, 60(23), 778–80.
- Allison, D. B., Fontaine, K. R., Manson, J. E., Stevens, J., & VanItallie, T. B. (1999). Annual deaths attributable to obesity in the United States. *JAMA: the journal of the American Medical Association*, 282(16), 1530–8.
- Bond, A. J., Verheyden, S. L., Wingrove, J., Curran, H.V. (2004). Angry cognitive bias, trait aggression and impulsivity in substance users. *Psychopharmacology*. 171, 331-339.
- Cabanac, M., & Johnson, K. G. (1983). Analysis of a conflict between Palatability and cold exposure in rats. *Physiology & Behavior*, 31(2), 249–253.
- Carels, R. a, Hoffman, J., Collins, a, Raber, a C., Cacciapaglia, H., & O'Brien, W. H. (2001). Ecological momentary assessment of temptation and lapse in dieting. *Eating behaviors*, 2(4), 307–21.
- Centers for Disease Control and Prevention. (2011). Overweight and obesity. Retrieved from <http://www.cdc.gov/obesity/index.html>
- Contento, I. R., Williams, S. S., Michela, J. L., & Franklin, A. B. (2006). Understanding the food choice process of adolescents in the context of family and friends. *The Journal of adolescent health: official publication of the Society for Adolescent Medicine*, 38(5), 575–82.
- Erlanson-Albertson. (2005) How palatable food disrupts appetite regulation. *Basic & clinical pharmacology & toxicology*, 97(2), 61-73.
- Everitt, B. J., & Robbins, T. W. (2005). Neural systems of reinforcement for drug addiction: from actions to habits to compulsion. *Nature neuroscience*, 8(11), 1481–9.
- Geiger, B. M., Haburcak, M., Avena, N. M., Moyer, M. C., Hoebel, B. G., & Pothos, E. N. (2009). Deficits of mesolimbic dopamine neurotransmission in rat dietary obesity. *Neuroscience*, 159(4), 1193–9.
- Goris, A. H. C., & Westerterp, K. R. (2008). Physical activity, fat intake and body fat. *Physiology & behavior*, 94(2), 164–8.
- Guerrieri, R., Nederkoorn, C., Schrooten, M., Martijn, C., & Jansen, A. (2009). Inducing impulsivity leads high and low restrained eaters into overeating, whereas current dieters stick to their diet. *Appetite*, 53(1), 93–100.
- Haines, J., Neumark-sztainer, D., Wall, M., Story, M., & Personal, M. S. (2007). Personal, Behavioral, and Environmental Risk and Protective Factors for Adolescent Overweight. *Obesity*, 15(11), 2748–2760.
- Hartmann AS, Rief W, Hilbert A (2011). Psychometric properties of the German version of the Barratt Impulsiveness Scale, Version 11 (BIS-11) for adolescents. *Perceptual and Motor Skills*, 112(2), 353-368.
- Hartmann, A. S., Rief, W., & Hilbert, A. (2012). Laboratory snack food intake, negative mood, and impulsivity in youth with ADHD symptoms and episodes of loss of control eating. Where is the missing link? *Appetite*, 58(2), 672–8.
- Hedley, A. A., Ogden, C. L., Johnson, C. L., Carroll, M. D., Curtin, L. R., & Flegal, K. M. (2004). Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002. *JAMA: the journal of the American Medical Association*, 291(23), 2847–50.

- Kenny, P. J. (2011). Reward mechanisms in obesity: new insights and future directions. *Neuron*, *69*(4), 664–79.
- Lane, S. D., Moeller, F. G., Steinberg, J.L., Buzby, M., Kosten, T.R. (2007). Performance of cocaine dependent individuals and controls on a response inhibition task with varying levels of difficulty. *American Journal of Drug and Alcohol Abuse*, *33*. 717-716
- Larson, N. I., Neumark-Sztainer, D., Hannan, P. J., & Story, M. (2007). Trends in adolescent fruit and vegetable consumption, 1999-2004: project EAT. *American journal of preventive medicine*, *32*(2), 147–50.
- Larson, N. I., Neumark-Sztainer, D., & Story, M. (2009). Weight control behaviors and dietary intake among adolescents and young adults: longitudinal findings from Project EAT. *Journal of the American Dietetic Association*, *109*(11), 1869–77.
- Liu, S., Manson, J. E., Lee, I. M., Cole, S. R., Hennekens, C. H., Willett, W. C., & Buring, J. E. (2000). Fruit and vegetable intake and risk of cardiovascular disease: the Women's Health Study. *The American journal of clinical nutrition*, *72*(4), 922–8.
- Luengo, M. A., Carrillo-De-La-Peña, M. T., & Otero, J. M. (1991). The components of impulsiveness: A comparison of the I.7 impulsiveness questionnaire and the Barratt impulsiveness scale. *Personality and Individual Differences*, *12*(7), 657–667.
- Lutter, M., & Nestler, E. J. (2009). Homeostatic and hedonic signals interact in the regulation of food intake. *The Journal of nutrition*, *139*(3), 629–32.
- Malik, V. S., Popkin, B. M., Bray, G. A., Despres, J.-P., Willett, W. C., & Hu, F. B. (2010). Sugar-Sweetened Beverages and Risk of Metabolic Syndrome and Type 2 Diabetes. *Diabetes Care*, *33*(11), 2477–2483.
- Moeller, F. G., Dougherty, D. M., Barratt, E. S., Schmitz, J. M., Swann, A. C., & Grabowski, J. (2001). The impact of impulsivity on cocaine use and retention in treatment. *Journal of Substance Abuse Treatment*, *21*(4), 193–198.
- Must, A., & Strauss, R. S. (1999). Risks and consequences of childhood and adolescent obesity. *International Journal of Obesity*, *23*, S2–S11.
- Nederkorn, C., Guerrieri, R., Havermans, R. C., Roefs, A., & Jansen, A. (2009). The interactive effect of hunger and impulsivity on food intake and purchase in a virtual supermarket. *International journal of obesity (2005)*, *33*(8), 905–12.
- Nederkorn, Chantal, Braet, C., Van Eijs, Y., Tanghe, A., & Jansen, A. (2006). Why obese children cannot resist food: the role of impulsivity. *Eating behaviors*, *7*(4), 315–22.
- Nestler, E. J. (2001). Molecular basis of long-term plasticity underlying addiction. *Nature reviews. Neuroscience*, *2*(2), 119–28.
- Nicklas, T. A., Yang, S.-J., Baranowski, T., Zakeri, I., & Berenson, G. (2003). Eating patterns and obesity in children. The Bogalusa Heart Study. *American journal of preventive medicine*, *25*(1), 9–16.
- Niv, S., Tuvblad, C., Raine, A., Wang, P., & Baker, L. A. (2012). Heritability and longitudinal stability of impulsivity in adolescence. *Behavior genetics*, *42*(3), 378–92.
- Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., & Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States, 1999-

2004. *JAMA: the journal of the American Medical Association*, 295(13), 1549–55.
- Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Patton Factor Structure of the BIS.pdf. *Journal of Clinical Psychology*, 51(6), 768–774.
- Piernas, C., & Popkin, B. M. (n.d.). Trends in snacking among U.S. children. *Health affairs (Project Hope)*, 29(3), 398–404.
- Piernas, C., & Popkin, B. M. (2011). Increased portion sizes from energy-dense foods affect total energy intake at eating occasions in US children and adolescents: patterns and trends by age group and sociodemographic characteristics, 1977–2006. *The American journal of clinical nutrition*, 94(5), 1324–32.
- Reid, M., Bunting, J., & Hammersley, R. (2005). Relationships between the Food Expectancy Questionnaire (FEQ) and the Food Frequency Questionnaire (FFQ). *Appetite*, 45(2), 127–36.
- Rockett, H. R., Wolf, A. M., & Colditz, G. A. (1995). Development and reproducibility of a food frequency questionnaire to assess diets of older children and adolescents. *Journal of the American Dietetic Association*, 95(3), 336–40.
- Rockett, H. R., Breitenbach, M., Frazier, a L., Witschi, J., Wolf, a M., Field, a E., & Colditz, G. a. (1997). Validation of a youth/adolescent food frequency questionnaire. *Preventive medicine*, 26(6), 808–16.
- Spinella, M. (2007). Normative data and a short form of the Barratt Impulsiveness Scale. *The International journal of neuroscience*, 117(3), 359–68.
- Stanford, M. S., Greve, K. W., Boudreaux, J. K., Mathias, C. W., & L. Brumbelow, J. (1996). Impulsiveness and risk-taking behavior: comparison of high-school and college students using the Barratt Impulsiveness Scale. *Personality and Individual Differences*, 21(6), 1073–1075.
- Stanford, M. S., Mathias, C. W., Dougherty, D. M., Lake, S. L., Anderson, N. E., & Patton, J. H. (2009). Fifty years of the Barratt Impulsiveness Scale: An update and review. *Personality and Individual Differences*, 47(5), 385–395.
- Swann, A. C., Dougherty, D. M., Pazzaglia, P. J., Pham, M., & Moeller, F. G. (2004). Impulsivity: a link between bipolar disorder and substance abuse. *Bipolar disorders*, 6(3), 204–12.
- Vartanian, L., Schwartz, B., & Brownell, K. (2007). Effects of Soft Drink Consumption on Nutrition and Health: A Systematic Review and Meta-Analysis.
- Volkow, N. D., & Wise, R. A. (2005). How can drug addiction help us understand obesity? *Nature neuroscience*, 8(5), 555–60. doi:10.1038/nn1452
- Wang, G.-J., Volkow, N. D., Telang, F., Jayne, M., Ma, J., Rao, M., Zhu, W., et al. (2004). Exposure to appetitive food stimuli markedly activates the human brain. *NeuroImage*, 21(4), 1790–7.