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Relationships of cognitive load on eating and weight-related behaviors of young adults

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ABSTRACT

Little is known about the relationship between weight-related behaviors and cognitive load (working memory available to complete mental activities like those required for planning meals, selecting foods, and other health-related decisions). Thus, the purpose of this study was to explore associations between cognitive load and eating behaviors, physical activity, body mass index (BMI), and waist circumference of college students. College students ($n = 1018$) from 13 institutions completed an online survey assessing eating behaviors (e.g., routine and compensatory restraint, emotional eating, and fruit/vegetable intake), stress level, and physical activity level. BMI and waist circumference were measured by trained researchers. A cognitive load score was derived from stress level, time pressure/income needs, race and nationality. High cognitive load participants ($n = 425$) were significantly ($P < 0.05$) more likely to be female, older, and further along in school than those with low cognitive loads ($n = 593$). Compared to low cognitive load participants, high cognitive load participants were significantly more likely to eat <5 cups of fruits/vegetables/day, have greater routine and compensatory restraint, and greater susceptibility to eating in response to external cues and emotional eating. Both males and females with high cognitive load scores had a non-significant trend toward higher BMIs, waist circumferences, and drinking more alcohol than low cognitive load counterparts. In conclusion, cognitive load may be an important contributor to health behaviors. Understanding how cognitive load may affect eating and other weight-related behaviors could potentially lead to improvements in the effectiveness of obesity prevention and intervention programs.

1. Introduction

The rate of obesity and related co-morbidities in the United States continues to climb despite the high value placed on nutrition and health, and the widespread availability of nutrition information for making healthier lifestyle choices (American Dietetic Association, 2011; Ogden et al., 2012, 2014). Although factors affecting eating behaviors and body weight have been the subject of thousands of studies, the relationship of cognitive load to these factors remains largely unexplored.

Cognitive load is a term that describes the amount of working memory a person has available at any time to apply to a task (Paas et al., 2004), such as selecting foods at a grocery store or planning a meal. Working memory is the extent to which cognitive resources are available to actively access short- and long-term memory and manipulate this stored information to complete complex mental activities, such as problem-solving, decision making, and following instructions (Cowan, 2008; Dehn, 2008). Working memory is generally considered to be finite or of limited capacity, with the amount available varying depending on acute (e.g., emotional state, environmental diversions, fatigue) and/or chronic (e.g., racial discrimination, low income, oppressive home and/or work conditions) stressors that may be real or perceived (Cohen et al., 2006; Paul et al., 2008; Redmond et al., 2013; Schetter et al., 2013).

Cognitive load theory suggests that during complex mental activities, the amount of information and interactions that must be processed simultaneously can range from under loading to overloading available working memory, and all elements of the mental activity must be processed before meaningful learning, problem solving, or decision making can continue (Paas et al., 2004). The more information the brain has to manipulate using the executive control of an individual's working memory, the higher the cognitive load. Stressors reduce cognitive resources available for meaningful processing of information and, thus, increase cognitive load.

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As theorized by the Ironic Process Theory, high cognitive loads can inhibit successful activation of mental operations; this inhibition is believed to occur in daily life as a result of mental pressures, anxieties, lack of sleep, and stressors “cluttering” or “occupying” part of the available working memory (Wegner, 1994). In general, the Ironic Process Theory suggests that this inhibition of mental operations may lead individuals to perform behaviors contrary to what they intend to achieve (e.g., overeating in restrained eaters) as a consequence of having their cognitive load “too fully occupied” to allow them to behave in the intended manner (Wegner, 1994).

The Ironic Process Theory and reports in the literature (Boon et al., 2002; Lattimore & Maxwell, 2004; Wegner, 1994) suggest that factors (e.g., stress) that occupy and thereby reduce cognitive resources may be related to unhealthy eating behaviors and potentially other weight-related behaviors (Boon et al., 2002; Lattimore & Maxwell, 2004). Insufficient cognitive resources for focusing on desired eating behaviors may lead to undesirable behaviors, such as disinhibited eating (Boon et al., 2002; Lattimore & Maxwell, 2004). For example, female undergraduate students identified as restrained eaters from a self-report measure (i.e., Restraint Scale) consumed significantly more ice cream than unrestrained eaters when their cognitive load was increased in an experimental setting (Boon et al., 2002). A study that manipulated available cognitive resources found that healthy, undergraduate students given a high cognitive load were more likely to choose chocolate cake (63%) over a fruit salad than those given a low cognitive load (41%) (Shiv & Fedorikhin, 1999). Additionally, high cognitive loads may significantly worsen the healthfulness of food choices (Zimmerman & Shimoga, 2014), increase risk for heavy alcohol consumption (San Jose et al., 2000), and impair efforts to be physically active (Stults-Kolehmainen & Sinha, 2014). Prior research reveals that stress, similar to high cognitive load, may activate reward signal pathways in the brain that increase intake of highly palatable foods (Adam & Epel, 2007), high-fat foods (Zellner et al., 2006), and snack foods and decrease intake of fruit (Chunhong et al., 2007). Stress can initiate a physiological response that increases activation of the central sympathetic nervous system and the hypothalamic–pituitary–adrenal (HPA) axis, which can increase cortisol secretion that then is followed by visceral fat accumulation (Rosmond, 2003). Thus, it is possible that limited cognitive resources and/or increased stress may promote unhealthy eating behaviors and concomitant outcomes, such as poor weight management, through both psychological and physiological pathways.

To date, most research has focused on perceived stress and objective measures of stress as a measure for cognitive load. However, recent research suggests that minorities and low-income communities may be susceptible to increased cognitive load due to the daily hassles and stressors experienced (Aneshensel, 2009; Hatch & Dohrenwend, 2007). For instance, on average, for every 1.2 stress-related events Whites experience, African-Americans experience 1.92 and American-born Latinos 1.90 stress-related events (Strenthal et al., 2001). Additionally, there are significant relationships between minority race/ethnicities and both low-income and lower educational attainment (Strenthal et al., 2001). Thus, it may be important to examine minorities and low-income individuals as it relates to cognitive load and weight-related behaviors.

Given that young adults enrolled in college are at risk for adopting unhealthy weight-related behaviors (e.g., decreased physical activity, increased alcohol intake) (Bell & Lee, 2006; Brown & Trost, 2003) and often have limited resources (e.g., time), understanding how cognitive load affects their weight-related behaviors could lead to improvements in the effectiveness of obesity prevention and intervention programs. Additionally, prior experimental studies examining increased cognitive load in relation to eating behaviors in the young adult population has been promising (Boon et al., 2002; Shiv & Fedorikhin, 1999). Thus, the purpose of this study was to further explore how cognitive load is associated with a more comprehensive array of characteristics and behaviors such as body mass index (BMI), waist circumference, eating behaviors, and physical activity of college students.

2. Material and methods

The members of the United States Department of Agriculture Multistate Healthy Campus Research Consortium developed and assessed Project YEAH (Young Adults Eating and Active for Health) (Multistate HCRC, 2014), a 15-month randomized, controlled obesity prevention intervention trial (Kattelmann, Byrd-Bredbenner, et al., 2014; Kattelmann, White, et al., 2014). The study reported here is a cross-sectional, secondary-analysis of baseline data. Project YEAH was approved by the Institutional Review Boards (IRB) from 13 universities. All participants gave informed consent and received modest monetary compensation to reimburse them for the time spent completing study measurements.

2.1. Sample and recruitment

Full-time students enrolled at the participating institutions were recruited using face-to-face methods (i.e., in-class and residential life housing meetings), e-mails, letters, and flyers were also posted on participating campuses (Brown et al., 2015). Eligible participants were 18 to 24 years of age and full-time first, second, or third year college students with Internet access. Participants majoring in nutrition, exercise science, and/or health promotion or enrolled in a nutrition course at time of study were ineligible to participate due to the potential for introducing biases in the obesity intervention trial. Other participants ineligible were underweight (i.e., body mass index [BMI] <18.5 kg/m^2); pregnant; and/or had a life-threatening illness or other diet and/or activity related medical restriction.

2.2. Measures

The baseline questionnaire dataset from Project YEAH, which evaluated eating behaviors, physical activity, perceived stress, anthropometric measurements, and demographic characteristics, was used in the study reported here. All survey measures have been widely used in the healthy, young adult population. Demographic data collected included age, gender, race/ethnicity, nationality (United States or non-United States), and hours employed weekly.

2.3. Anthropometric assessments

Weight, height, and waist circumference were measured in duplicate by trained study personnel. Participants wore light clothing, avoided food and/or beverages three hours before measurement, and voided their bladders immediately before measurement.

Weight was assessed to the nearest 0.1 kg using either a digital or balance beam scale calibrated using standard weights prior to measurements. Height was assessed to the nearest 0.1 cm using a wall mounted stadiometer. Measurements were repeated if two measurements were not within 0.1 cm or 0.1 kg. BMI was calculated using the formula of weight (kg) / [height (m^2)] (Centers for Disease Control and Prevention, 2011). The average of height and weight measures was used to calculate BMI.

Waist circumference was measured to the nearest 0.1 cm at the level of the iliac crest using Gulick fiberglass, non-stretchable tensioned tape, assuring the tape was in a horizontal plane and not twisted. Measurements were repeated if there was >0.5 cm difference between the measurements until both were within 0.5 cm.

2.4. Eating behaviors

The 19-item, National Cancer Institute (NCI) Fruit and Vegetable Screener was used to assess fruit and vegetable daily intake in cups