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Research report

Executive functioning, emotion regulation, eating self-regulation, and weight status in low-income preschool children: How do they relate? ☆

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ABSTRACT

The purpose of the present study was to examine relationships between child eating self-regulation, child non-eating self-regulation, and child BMIz in a low-income sample of Hispanic families with preschoolers. The eating in the absence of hunger task as well as parent-report of child satiety responsiveness and food responsiveness were used to assess child eating self-regulation. Two laboratory tasks assessing executive functioning, a parent questionnaire assessing child effortful control (a temperament dimension related to executive functioning), and the delay of gratification and gift delay tasks assessing child emotion regulation were used to assess child non-eating self-regulation. Bivariate correlations were run among all variables in the study. Hierarchical linear regression analyses assessed: (1) child eating self-regulation associations with the demographic, executive functioning, effortful control, and emotion regulation measures; and (2) child BMI z-score associations with executive functioning, effortful control, emotion regulation measures, and eating self-regulation measures. Within child eating self-regulation, only the two parent-report measures were related. Low to moderate positive correlations were found between measures of executive functioning, effortful control, and emotion regulation. Only three relationships were found between child eating self-regulation and other forms of child self-regulation: eating in the absence of hunger was positively associated with delay of gratification, and poor regulation on the gift delay task was associated positively with maternal reports of food responsiveness and negatively with parent-reports of satiety responsiveness. Regression analyses showed that child eating self-regulation was associated with child BMIz but other forms of child self-regulation were not. Implications for understanding the role of self-regulation in the development of child obesity are discussed.

Introduction

Most researchers agree that a major factor contributing to high levels of childhood obesity is the environment to which children are exposed on a daily basis (Lake & Townshend, 2006; Wansink, 2004). In the United States, young people grow up in environments where palatable, inexpensive, high-calorie, low nutrient-dense foods are almost always readily available; where soft drinks and energy drinks are often the drink of choice; and where a large portion of daily calories come from heavily marketed, high-calorie, low-nutrient convenience foods (either in the home or at restaurants) often served in large portions. Because some children manage to maintain a healthy weight in the current "obesogenic" environment, a number of childhood obesity researchers have turned their attention to the role of children's self-regulation in the development of childhood obesity (Frankel et al., 2012; French, Epstein, Jeffery, Blundell, & Wardle, 2012; Laing, Matheson, Kaye, & Boutelle, 2014). The assumption of these researchers is that individual differences in child self-regulation may be one factor that contributes to some children's tendency not to consume too many calories, despite significant environmental pressures to do so.

Various types of self-regulation have been negatively related to child adiposity, obesity, and/or weight status. Eating self-regulation

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refers to the ability (inborn and socialized) to eat and not eat in response to internal cues of hunger and fullness (Baumeister & Vohs, 2004). There are two types of eating self-regulation – satiation and satiety. As described by Bellisle, Drewnowski, Anderson, Westerterp-Plantenga, and Martins (2012), "Satiation occurs during an eating episode and brings it to an end. Satiety starts after the end of eating and prevents further eating before the return of hunger" (p. 1149S). Satiation, which is negatively associated with child weight status (Faith et al., 2012; Johnson & Birch, 1994; Kral et al., 2012), is usually measured by examining intake at a meal when various aspects of that meal have been manipulated. A commonly used approach with children is to examine the effects of a preload on subsequent intake at a meal (e.g., Johnson & Birch, 1994). Satiety, the other type of eating self-regulation, is usually measured in children by assessing eating in the absence of hunger (Fisher & Birch, 1999). Because eating in the absence of hunger reflects low levels of satiety, it is positively associated with child weight status (Butte et al., 2007; Fisher & Birch, 1999, 2002; Francis & Birch, 2005; Hill et al., 2008; Moens & Braet, 2007; Shoemaker et al., 2010).

Wardle, Guthrie, Sanderson, and Rapoport (2001) developed a parent-report questionnaire, the Children's Eating Behavior Questionnaire (CEBQ), which assesses constructs related to satiation and satiety. Two of their scales, Food Responsiveness (referring to how responsive the child is to food and eating) and Satiety Responsiveness (referring to child responsiveness to feelings of fullness), were used in the present study. Both subscales are significantly associated with weight status in young children, with food responsiveness showing a positive relationship and satiety responsiveness a negative one (Carnell & Wardle, 2008; Sleddens, Kremers, & Thijs, 2008; Viana, Sinde, & Saxton, 2008; Webber, Hill, Saxton, Van Jaarsveld, & Wardle, 2009).

Besides eating self-regulation, executive functioning has been associated with childhood obesity as well (see Laing et al., 2014 for a recent review). Executive functioning reflects a number of cognitive functions that are processed by the prefrontal cortex and required for such activities as carrying out plans, obeying social rules, and adapting to changing environmental circumstances (Grafman & Litvan, 1999). Core executive functions for preschool children are inhibitory control, cognitive flexibility, and working memory (Diamond, Barnett, Thomas, & Munro, 2007). Studies examining the different components of executive functioning show that differences in child weight status are usually only significant for response inhibition and cognitive flexibility, with few or inconsistent differences in intelligence, reasoning, working memory, and verbal fluency (Cserjesi, Molnar, Luminet, & Lenard, 2007; Laing et al., 2014; Verdejo-Garcia et al., 2010). Across studies, overweight and/or obese children tend to show lower levels of response inhibition and cognitive flexibility than healthy weight children.

Emotion regulation is also related to child weight status. Longitudinal studies show that delay of gratification – the ability to resist temptation for an immediate reward and wait for a later reward (Botano & Boland, 1983; Bruce et al., 2012) – is protective for the development of childhood obesity. Two separate analyses of data from the NICHD Study of Early Child Care and Youth Development found that delay of gratification in the preschool years was associated with lower child body mass index (BMI) at ages 11 (Seeyave et al., 2009) and 12 (Francis & Susman, 2009). In a separate study, Schlam, Wilson, Shoda, Mischel, and Ayduk (2013) found that children who exhibited greater delay of gratification in a laboratory at age four had lower BMIs thirty years later. Two additional studies showed that delay of gratification assessed in middle childhood negatively predicted BMI at age 13 (Duckworth, Tsukayama, & Geier, 2010; Evans, Fuller-Rowell, & Doan, 2012). Finally, Graziano, Calkins, and Keane (2010) and Graziano, Kelleher, Calkins, Keane, and Brien (2013), found that self-regulation assessed at age two (a combined measure of emotional regulation, delay of gratification, and sustained attention) negatively predicted child BMI at ages five and ten.

The satiety cascade (Blundell, 1991) helps describe the processes that trigger initial ingestion, terminate intake (satiation), and prevent subsequent intake after termination (satiety). The regulation of eating is a function of both homeostatic and hedonic factors (Harrold, Dovey, Blundell, & Halford, 2012). Homeostatic control helps ensure that sufficient calories are consumed to meet the body's energy needs, and once these needs have been met, ensures that negative feedback signals help bring the period of eating to an end. Hedonic factors, in contrast, are mediated by reward. The consumption of highly palatable foods, for example, can work against homeostatic control and lead to overconsumption. Poor self-regulation of eating, therefore, can be a function of homeostatic or hedonic factors and can be a function of factors at any point in the satiety cascade. Researchers offer several explanations for the relationships between executive functioning, emotion regulation, and childhood obesity. Most argue that, as a group, obese children may be susceptible to overeating due to inhibitory control deficits, cognitive inflexibility, and/or overly active food-related reward systems. As described by Delgado-Rico, Río-Valle, Gonzalez-Jimenez, Campoy, and Verdejo-Garcia (2012), "excessive eating and obesity are increasingly viewed as a brain-related dysfunction, whereby reward-driven urges for pleasurable foods 'hijack' context-driven frontal-executive control" (p. 1604). These interpretations are consistent with both Schachter's (1971) externality theory (i.e., that obese individuals are more responsive to environmental cues to eat) and Singh's (1973) inhibition deficit theory (i.e., that obese individuals have difficulties inhibiting responses to palatable food stimuli). Verdejo-Garcia et al. (2010), however, warn that the correlational nature of such data "cannot resolve if the association of BMI and executive function is due to the deleterious effects of increased weight on prefrontal blood flow and executive competence, or to the possibility that children with poor executive skills are more likely to become obese" (pp. 1576–1577).

Despite the rather large number of studies in this area, very few have examined the relationships *between* the various forms of child self-regulation across the eating and non-eating domains. If, indeed, the interpretations that are offered for the relationship between child self-regulation and obesity are correct, one would expect moderate to strong positive intercorrelations between measures of self-regulation within and across these two domains. Previous research shows that for the non-eating domain, within-domain correlations are usually small to moderate, with correlations between measures of executive functioning generally ranging between $r = 0.20$ and $r = 0.35$ (Bull & Scerif, 2001; Lehto, Juujarvi, Kooistra, & Pulkkinen, 2003; Wiebe, Espy, & Charak, 2008). Executive functioning and effortful control show similar correlations with measures of emotion regulation (see Spinrad, Eisenberg, & Gaertner, 2007 for a review). Within the eating domain, mothers' responses on the satiety responsiveness and food responsiveness subscales of the Children's Eating Behavior Questionnaire (CEBQ) are negatively correlated with one another (e.g., Frankel et al., 2014; Sleddens et al., 2008; Wardle et al., 2001). Fewer studies have examined inter-correlations of child eating self-regulation as measured by observed tasks and parent-reports of this construct. Carnell and Wardle (2007) examined the relationship between mothers' responses on the CEBQ and two laboratory assessments: caloric compensation trials (Johnson & Birch, 1994) and eating in the absence of hunger (Fisher & Birch, 1999) in a sample of 4- to 5-year-old children. The results showed no significant correlation between eating in the absence of hunger and child eating self-regulation as measured in the compensation trials. When they examined the relationship between mothers' responses on the CEBQ (food responsiveness and satiety responsiveness) and the laboratory measures of child eating self-regulation, only one relationship out of six was significant. Children whose mothers rated them high in satiety responsiveness were less likely to eat in the absence of hunger