



Observed infant food cue responsivity: Associations with maternal report of infant eating behavior, breastfeeding, and infant weight gain



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ABSTRACT

Infant obesity and the rate of weight gain during infancy are significant public health concerns, but few studies have examined eating behaviors in infancy. Food cue responsivity has been described as a key contributor to obesity risk in school age children and adults, but has been rarely examined during infancy. The purpose of the current study was to test among 30 infants aged 6–12 months the hypotheses that infants would show greater interest in food versus non-food stimuli, and that greater birth weight, greater rate of weight gain during infancy, greater mother-reported food responsiveness, being formula versus breastmilk fed, and higher maternal body mass index, would each be associated with greater interest in the food versus non-food stimulus. Results showed that overall infants showed a preference for the food versus non-food stimulus. Preference for the food versus non-food stimulus was predicted by greater infant rate of weight gain since birth, greater maternal-reported infant food responsiveness, and having been exclusively formula-fed, but not by any other factor tested. Results are discussed with regard to theoretical implications for the study of infant obesity and applied prevention implications.

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Observed Infant Food Cue Responsivity: Associations with Maternal Report of Infant Eating Behavior and Infant Weight Gain.

Obesity is a significant public health problem (Ogden, Carroll, Kit, & Flegal, 2014). Preventing obesity is much more effective than treating it (Epstein, Valoski, Wing, & McCurley, 1990; Epstein, Valoski, Wing, & McCurley, 1994) and once obesity is established it is very likely to persist throughout the lifespan (Freedman et al., 2005; Nader et al., 2006). Prevention is therefore critical. By age 2 years, 8.1% of children are already obese (Ogden et al., 2014). In addition, the rate of weight gain in the first year of life is a robust risk factor for obesity later in childhood and into adulthood, independent of prenatal factors or birth weight (Baird et al., 2005; Belfort, Rifas-Shiman, Rich-Edwards, Kleinman, & Gillman, 2007;

Botton et al., 2008; Dennison, Edmunds, Stratton, & Pruzeck, 2006; Ekelund et al., 2007; Larnkjaer et al., 2010; Ong & Loos, 2006; Sachdev et al., 2005; Stettler et al., 2005; Taveras et al., 2011). The mechanism of rapid weight gain in the first year of life is currently unknown. As a result, there has been a call for additional research on the contributors to the development of obesity in children younger than age 2 years (Lumeng, Taveras, Birch, & Yanovski, 2015).

A growing focus in obesity research across the lifespan has been the role of food cue responsivity in contributing to obesity risk. Food cue responsivity is defined as the degree to which external food cues, such as the sight of food, encourage an individual to eat, potentially to excess (Carnell, Susan, Benson, Pryor, & Driggin, 2013). This appetitive trait has commonly been assessed in a number of ways. One approach has been to give children the opportunity to eat to satiety and then choose between eating palatable snacks or playing with toys (Birch, Fisher, & Davison, 2003). Others have evaluated attentional bias for food using implicit assessments (Carnell, Benson, Pryor, & Driggin, 2013). An additional

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related construct is the willingness to consciously work to obtain food (i.e., the reinforcing value of food) (Epstein, Leddy, Temple, & Faith, 2007). Food cue responsivity in children has also been measured by parental report of food responsiveness and enjoyment of food (Wardle, Guthrie, Sanderson, & Rapoport, 2001a). Greater food cue responsivity measured through a range of these approaches has been associated with greater rates of obesity or weight gain in school age children (Braet & Crombez, 2003; Carnell & Wardle, 2008; Fisher et al., 2007; Hill, Saxton, Webber, Blundell, & Wardle, 2009; Hill et al., 2008; Nederkoorn, Coelho, Guerrieri, Houben, & Jansen, 2012; Seeyave et al., 2009; Temple, Legierski, Giacomelli, Salvy, & Epstein, 2008).

Limited research has examined food cue responsivity in children younger than age 2 years. Parent report that an infant has “a good appetite” (Wright, Parkinson, & Drewett, 2006) or greater enjoyment of food and food responsiveness (van Jaarsveld, Llewellyn, Johnson, & Wardle, 2011) at younger than age 3 months predicted greater rates of weight gain in later infancy. Vigorous sucking patterns in early infancy, which may reflect food cue responsivity, have been linked with greater rates of infant weight gain (Agras, Hammer, McNicholas, & Kraemer, 2004; Agras, Kraemer, Berkowitz, & Hammer, 1990; Agras, Kraemer, Berkowitz, Korner, & Hammer, 1987; Waterland, Berkowitz, Stunkard, & Stallings, 1998). Only recently have researchers begun to use experimental protocols to interrogate infant eating behaviors besides infant sucking. In experimental studies with 9- to 18-month old infants, greater relative reinforcing value of food was linked with higher infant weight status (Kong, Fedá, Eiden, & Epstein, 2015). The need for additional approaches to examining infant eating behavior in experimental settings has been noted, in particular the examination of differential attention between two objects when food and non-food alternatives are presented in a concurrent fashion (Kong et al., 2015).

Infant feeding history may be an important factor to consider as it relates to infant food responsiveness. Infants who are formula-fed have an increased risk for overweight and obesity compared to breastfed infants (Butte, Wong, Hopkinson, Smith, & Ellis, 2000; Li, Fein, & Grummer-Strawn, 2008; Owen, Martin, Whincup, Smith, & Cook, 2005). Hypothesized mechanisms include improved satiety responsiveness in breastfed infants (e.g. Brown & Lee, 2012), differences in protein composition of formula versus breastmilk (e.g., Koletzko et al., 2009), and a less controlling maternal feeding style with breastfeeding (Taveras et al., 2006), allowing for greater infant satiety responsiveness (DiSantis, Collins, Fisher, & Davey, 2011; Ventura & Birch, 2008). There is a relative gap in the literature relating to food responsivity during this developmental period, especially as it relates to mode of feeding. In one observational study, although infants who were breastfed longer were rated by their mothers as more satiety responsive at 18–24 months, mode of feeding was not related to food responsivity (Brown & Lee, 2012). Similarly, in another study there was no association of formula-feeding with food responsiveness at 3–6 years of age, but the formula-fed group was quite small, limiting the power to find group differences (DiSantis et al., 2011). Neither of the studies (Brown & Lee, 2012; DiSantis et al., 2011) reported on food responsivity during infancy. To our knowledge, no studies have investigated the association of mode of feeding with food responsivity during infancy. DiSantis and colleagues reported that higher food responsiveness was related to a history of rapid growth. Formula-fed infants are at higher risk for early rapid growth, which is a risk factor for future overweight and obesity (Koletzko, Akerblom, Dodds, & Ashwell, 2005). Higher food responsivity in formula versus breastfed infants may be a mechanism explaining the higher risk for overweight and obesity in this group.

The current study therefore sought to examine observed infant

food cue responsivity among 30 infants aged 6–12 months in the context of a novel behavioral protocol pitting a food versus non-food stimulus against one another. We sought to test several hypotheses. First, given the primacy of food as a behavioral reinforcer beginning in infancy (Gentry & Aldrich, 1948; Rosenstein & Oster, 1988), we hypothesized that overall, infants would show greater interest in the food versus non-food stimuli. Second, we hypothesized based on prior research linking maternal report of better infant appetite with infant weight gain (van Jaarsveld et al., 2011), that infants with greater birth weight or greater rate of weight gain since birth would show greater interest in the food versus non-food stimuli. Third, based on previous findings of good cross-validation between maternal report of children's eating behaviors and child behavioral measures (Carnell & Wardle, 2007) we hypothesized that infants whose mothers described them as more food responsive would show more interest in the food versus non-food stimulus. Fourth, given findings that breastfeeding is associated with better satiety responsiveness (Brown & Lee, 2012), we hypothesized that breastfeeding would be associated with reduced food responsiveness, a related but distinct construct. Finally, given associations between maternal and child weight (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997), we hypothesized maternal higher body mass index would predict greater infant interest in the food, as compared to the non-food stimulus.

1. Method

1.1. Participants and recruitment

Thirty healthy, full term 6-, 9-, and 12-month old infants recruited from the community participated. Mothers were told that the researchers were interested in “learning about infant preferences and infant behaviors relating to those preferences.” Inclusion criteria were that the infant was born at full term (≥ 37 weeks gestation), following an uncomplicated pregnancy without perinatal or neonatal complications, with a birth weight appropriate for gestational age ($\geq 10^{\text{th}}$ and $\leq 90^{\text{th}}$ percentile for gestational age and sex), without any current developmental delays, food allergies or intolerances or significant medical problems, and from a home where English was the primary language spoken. The sample was comprised of ten 6-month olds (6 boys, $M_{\text{age}} = 6.04$; $SD = 0.42$), ten 9-month olds (7 boys, $M_{\text{age}} = 9.24$; $SD = 0.43$), and ten 12-month olds (6 boys, $M_{\text{age}} = 12.25$; $SD = 0.23$), 82.8% of whom were White (one participant did not have race data reported, therefore $N = 29$). Average gestational age was 39.63 weeks ($SD = 1.25$). Mothers ranged in age from 23 to 41 years ($M = 31.17$, $SD = 5.09$), 86.2% were White, and 65.6% had completed a 4-year degree or more. Average infant birthweight was 3.45 kg ($SD = 0.41$).

1.2. Procedures

During the experiment, infants sat on their mothers' laps, centered in front of a tray (18" \times 14") that was clipped onto a table, with the experimenter sitting directly across from the infant. Mothers were instructed to adjust the height of the chair so that the infant was able to reach the most distal part of the tray. Mothers were also asked to wear a blindfold and to limit interactions with the infant to prevent unintentionally influencing the infants' reactions and choices. In order to reduce distraction for the infant, the experimenter wore a dark colored visor and lowered her head to cover her eyes during the tasks. All parts of the experiment were videotaped.

Infants were presented with six pairs of small clear plastic containers, which were sealed on all four sides with clips. Each pair included a food item and a visually similar toy item (See Fig. 1). The

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