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Research report

Impulsivity and overeating in children in the absence and presence of hunger

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ABSTRACT

Overweight children appear to be more responsive to environmental, hedonic cues and easily overeat in the current obesogenic environment. They are also found to overeat in the absence of hunger, and this overeating seems related to impulsivity: impulsive participants are more prone to external eating. However, some studies showed that impulsive adults are also more prone to hunger cues: impulsive participants overate especially when feeling hungry. This would mean impulsive people are more reactive to both external and internal cues. The overeating was limited to palatable high energy-dense foods: hunger made them fancy a snack. In the current study, we wanted to test the interaction between impulsivity, hunger and consumption of food type in children. Impulsivity was measured in 88 children between the ages of 7 and 9. Next, half of the participants performed a taste test before their own regular lunch and half of the participants immediately after their lunch. During the taste test, low, medium and high energy-dense food items were presented. Results showed that impulsive children ate more high energy-dense foods than low impulsive children, both before and after their lunch. No differences were found on low or medium energy-dense foods. Impulsive children therefore showed normal sensitivity for internal hunger and satiety cues, but abnormal response to high energy-dense foods. This might render them vulnerable to tasty temptation in the environment and to weight gain in their future.

Introduction

Childhood obesity is a major concern nowadays. In order to fight childhood obesity effectively, it is important to know its main causes. One problem is the abundant availability of relatively cheap, palatable, high caloric foods, which can easily lead to eating more than needed. Numerous studies showed that increased portion size (Rolls, 2003), high energy density of food and the relatively low costs of energy dense foods (Drewnowski & Specter, 2004) and aggressive advertisement of palatable high caloric foods (Andreyeva, Kelly, & Harris, 2011; Nestle, 2006) all contribute to increased intake and obesity. However, not all children become obese, suggesting that some children might be more responsive to the obesogenic environment than others. In 2013, around 12.6% of the children were obese in the United States and 6.8% in Western Europe (Ng et al., 2014). Indeed, research showed that overweight children respond stronger to food cues (Carnell & Wardle, 2008; Halford, Gillespie, Brown, Pontin, & Dovey, 2004; Jansen et al., 2003) and are less effective in inhibiting their responses towards food cues (Nederkoorn, Coelho, Guerrieri, Houben, & Jansen, 2012), compared to children with a healthy weight. Overweight children might act more in response to hedonic hunger, instead of relying on homeostatic cues of hunger and satiety (Appelhans, 2009). This is in line with the externality theory of Schachter (1971; Schachter & Rodin, 1974), which states that obese individuals are more reactive to external cues and less sensitive to internal cues, like hunger and satiety. To measure hedonic eating, a frequently used paradigm is eating in the absence of hunger. During this procedure, children are first asked to eat until sated during a meal and next, to perform a taste test with palatable snack foods. Results showed that overweight children overeat more in the absence of hunger (Fisher & Birch, 2002; Kral et al., 2012), and overeating in the absence of hunger is predictive of weight gain and becoming overweight in the future (Shunk & Birch, 2004). An extensive literature is focused on eating in the absence of hunger, using it for instance as an outcome variable for treatment for overweight children (Boutelle et al., 2011). Eating in the absence of hunger is considered an index of disinhibited eating (Francis, Ventura, Marini, & Birch, 2007) and lower impulsivity appeared related to more responsiveness to internal satiety cues (Tan & Holub, 2011), whereas higher impulsivity has been related to higher external eating (Farrow, 2012; Hou et al., 2011; Jasinska et al., 2012) and more responsiveness to food cues (for an overview, see: Van den Akker, Stewart, Antoniou, Palmberg, & Jansen, 2014).

The fact that high impulsive people eat more than low impulsive people when being sated does not exclude the possibility they

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might also eat more when feeling hungry. Hunger is a general trigger to eat; it increases reactivity to food cues (Brunstrom, Yates, & Witcomb, 2004) and makes especially high caloric foods more rewarding (Siep et al., 2009). Perhaps it is an even more important trigger for impulsive people. Indeed, Nederkoorn, Guerrieri, Havermans, Roefs, and Jansen (2009) found that high impulsive, disinhibited participants tend to eat more than low impulsive participants, but especially when feeling hungry. Without hunger, no differences in intake were found between low and high impulsive participants. This finding was replicated in another study, in which variety of food was manipulated (Guerrieri, Stanczyk, Nederkoorn, & Jansen, 2012). Impulsive, reward sensitive participants ate more during a varied food taste test than during a monotonous food test, but only when feeling hungry. Without hunger, variety of food did not influence intake. In low impulsive participants, hunger and variety did not affect intake at all. These findings suggest impulsive people are more sensitive not only to external but also to internal cues: hunger is the best sauce and by increasing the savour of food, hunger might increase the demand on inhibitory control to prevent overeating. In both experiments, the hunger was modest: participants only withheld from eating for several hours. Mild hunger might therefore be enough to trigger disinhibited eating. However, in both studies, adults were measured. This raises the question whether children react similarly, meaning that more impulsive children tend to overeat primarily when feeling hungry and not while sated. Alternatively, it is possible that impulsive children are not able to control their intake of palatable foods, irrespective of their level of satiation, and overeat in both conditions. In general, inhibitory control in children is less developed compared to adults, due to immature prefrontal activation (Bunge, Dudukovic, Thomason, Vaidya, & Gabrieli, 2002), which might cause them to indulge in tasty foods under all circumstances. Adults might have learned to control their intake in less tempting situations and only fail to inhibit themselves when the desire to eat is high.

In the present study, we therefore wanted to test whether impulsive children eat more compared to low impulsive children, when hungry or sated. Impulsivity is measured during a first test day and hunger is manipulated during a second test day, in order to isolate these effects. During the taste test, low, medium and high energy-dense foods are presented. Based on the previous finding that impulsive participants especially overeat high energy-dense (HED) foods (Nederkoorn et al., 2009), we expect that high impulsive children eat particularly more HED foods, compared to low impulsive children. It is not expected that impulsivity has an influence on intake of low or medium energy dense (LED or MED) foods. Moreover, we expect that the group differences will be more pronounced in the hunger condition, meaning that we expect a three-way interaction between hunger, impulsivity and energy-density.

Methods

Participants

A total of 92 children between 7 and 9 years old were tested on two separate days. Four children were excluded from analyses; one because of technical problems with the task, two children did not understand the task properly and one child appeared to be an influential case on the dependent variable (Cook's distance > 4/n). The mean age of the remaining 88 children was 8.1 (SD = .75), mean BMI was 16.2 (SD = 2.3) and mean BMI Z-score was –.068 (SD = .93). The sample consisted of 32 boys and 57 girls (see also the demographic characteristics in Table 1).

Measures

Response inhibition was measured with an adapted version of the Stop signal task (Logan, Schachar, & Tannock, 1997). This task involves a go and stop task. The go task was a choice reaction time task in which participants had to decide as fast as possible whether a square was presented on the left or right side of the computer screen, by pressing a corresponding button. In 25% of the trials (the stop trials) an auditory stop signal (1000 Hz, 100 ms) was presented, indicating that subjects had to inhibit their response. Initially, the stop signal delay was set at 250 ms after the presentation of the go signal and then adjusted dynamically depending on the responses of the subject. After a correct inhibition of the response, the delay was increased by 50 ms, making the next trial more difficult. After an incorrect response, the delay is decreased by 50 ms, making the next trial somewhat easier. The two variables measured in this task are the reaction time (RT) and the stop delay. Stop signal reaction time (SSRT) is calculated by subtracting the mean stop delay from the mean reaction to the go-trials. Higher SSRTs mean that children needed more time to inhibit a response and are indicative of less effective response inhibition.

Hunger was measured on a scale ranging from 1 (not hungry at all) to 10 (very hungry). The meaning of the numbers was visually clarified with a manikin with an empty stomach above the number 1, a manikin with a half full stomach above the numbers 5 and 6 and a manikin with a full stomach above the number 10. In addition, the experimenter explained the meaning of the numbers to each child.

An **ad lib taste test** was used to measure food intake. Each child received 6 bowls, of which 2 bowls were filled with LED foods (150 g grapes, 78 kcal per 100 g, 120 g carrots, 33 kcal per 100 g), two were filled with MED foods (37 g crackers, 377 g per 100 g and 70 g gingerbread, 309 kcal per 100 g) and two filled with HED foods (180 g M&Ms, 519 kcal per 100 g and 65 g crisps, 542 kcal per 100 g). The child was asked to rate the taste of each food on a 3 point scale

Table 1
Demographic characteristics and test scores of the participants.

	Before lunch Low impulsive	Before lunch High impulsive	After lunch Low impulsive	After lunch High impulsive
N	23	22	21	22
Age	8.3 (.7)	8.0 (.8)	8.0 (.8)	8.1 (.7)
Proportion of boys	26.1	40.9	23.8	50
BMI	15.7 (1.3)	16.0 (2.3)	16.2 (1.7)	16.8 (3.3)
BMI Z-score	–.25 (.8)	–.12 (.86)	.03 (.86)	.08 (1.2)
Hunger	8.0 (1.8)	7.1 (1.9)	5.5 (1.9)	5.8 (1.9)
SSRT (in ms)	279.0 (51.8)	408.4 (63.9)	286.7 (36.4)	410.2 (59.1)
Total intake (in kcal)	336.4 (121.8)	385.2 (130.4)	262.6 (113.9)	312.7 (115.5)
HED intake	230.7 (100.6)	279.1 (151.7)	168.2 (116.2)	226.1 (123.2)
MED intake	59.4 (39.2)	67.6 (48.1)	61.6 (45.3)	52.5 (36.9)
LED intake	46.3 (42.8)	38.5 (38.0)	32.8 (33.8)	34.0 (39.9)