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UnAdulterated — Children and adults' visual attention to healthy and unhealthy food

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ABSTRACT

Objective: Visually attending to unhealthy food creates a desire to consume the food. To resist the temptation people have to employ self-regulation strategies, such as visual avoidance. Past research has shown that self-regulatory skills develop throughout childhood and adolescence, suggesting adults' superior self-regulation skills compared to children.
Methods: This study employed a novel method to investigate self-regulatory skills. Children and adults' initial (bottom-up) and maintained (top-down) visual attention to simultaneously presented healthy and unhealthy food were examined in an eye-tracking paradigm.
Results: Results showed that both children and adults initially attended most to the unhealthy food. Subsequently, adults self-regulated their visual attention away from the unhealthy food. Despite the children's high self-reported attempts to eat healthily and importance of eating healthily, children did not self-regulate visual attention away from unhealthy food. Children remained influenced by the attention-driven desire to consume the unhealthy food whereas adults visually attended more strongly to the healthy food thereby avoiding the desire to consume the unhealthy option.
Conclusions: The findings emphasize the necessity of improving children's self-regulatory skills to support their desire to remain healthy and to protect children from the influences of the obesogenic environment.

1. Introduction

Adults screaming at the supermarket cashier because they are not allowed any candy are rarely encountered; screaming children, however, can be observed regularly. This is hardly due to adults not liking the offers of snacks but due to the fact that they, as opposed to children, self-regulate their eating behavior. The combination of omnipresent food temptations and people's desire to be healthy often causes self-control dilemmas (Crawford, 2006; Lake & Townshend, 2006; Serdula et al., 1999). To successfully resist food temptations people employ self-regulation strategies (Baumeister & Vohs, 2005).

Previous research revealed attentional biases to food compared to neutral objects (Nijs, Muris, Euser, & Franken, 2010), as well as to unhealthy, palatable compared to healthy food because these foods suggest rewarding experiences (DiPellegrino, Magarelli, & Mengarelli, 2011; Werthmann et al., 2011). Palatable food activates the reward system due to repeated coupling of the food cue and the rewarding consumption experience (Castellanos et al., 2009; Nijs et al., 2010). This incentive salience (Berridge, 2009) increases the attention to unhealthy food cues (Jansen et al., 2003) and the craving for the food (Castellanos et al., 2009; Field & Cox, 2008). Experimentally manipulated attention to unhealthy rather than healthy food has even shown to increase subsequent consumption (Werthmann, Field, Roefs, Nederkoorn, & Jansen, 2014) and field studies revealed increased consumption resulting from proximity and salience of food (Cohen & Farley, 2008; Maas, de Ridder, de Vet, & de Wit, 2012; Painter, Wansink, & Hieggelke, 2002; Wansink, Painter, & Lee, 2006).

Consequently, visual attention to unhealthy food may be harmful to successful resistance (Nijs et al., 2010; Werthmann, 2014a). In an attempt to prevent this cue-triggered urge to eat, people may self-regulate their visual attention to avoid the food, thereby resisting the temptation to eat and acting in consistence with long-term health goals (Berridge, Ho, Richard, & DiFeliceantonio, 2010). However, the required self-regulatory capacity is often insufficiently available (Baumeister, Heatherton, & Tice, 1994), because it weakens during previous exertion of self-control, for example when coping with stress and regulating emotions (Muraven & Baumeister, 2000).

Considering that self-regulatory skills develop throughout childhood and adolescence (Mischel, Shoda, & Rodrigues, 1989; Rothbart, Posner, & Kieras, 2006) adults should be better at visually avoiding food than children. To test this idea this study employed a novel method of comparing self-regulatory capacity between children and adults in an

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eye-tracking paradigm. Specifically, it tested whether they differ in their self-regulatory tendency to avoid unhealthy food by measuring visual attention, in terms of gaze direction and gaze duration, to healthy and unhealthy food.

Visual attention is presumably driven by two processes: Bottom-up processes are driven by stimulus features leading to involuntary and unconscious attentional shifts to potentially relevant stimuli. Thus, they are particularly strong during the early stages of visual exposure. Top-down processes are voluntary and conscious mechanisms that shift attention to goal-relevant stimuli meaning they gain influence at later stages (Connor, Egeth, & Yantis, 2004; Kean & Lambert, 2003, chap. 2). Consequently, bottom-up features, such as the attractiveness of a stimulus, should have a strong influence on early visual attention, whereas conscious goals and self-regulatory strategies should become more influential at a later stage. Thus, unregulated initial fixations should be influenced most strongly by the attractiveness of the food, whereas overall dwell time, reflecting maintained attention, should be more influenced by self-regulatory strategies related to an attempt to avoid the unhealthy food. However, these self-regulatory strategies should have a stronger impact on adults' than on children's maintained visual attention because children are supposedly less capable of self-regulation (Mischel et al., 1989).

Consequently, both children and adults should reveal an initial attentional bias toward unhealthy, attractive food. For maintained attention, adults that are motivated to avoid unhealthy food should exert self-regulatory strategies that lead them to avoid unhealthy food while children should reveal less influence of self-regulatory strategies. Their visual maintained attention should remain stronger on the unhealthy food.

This research provides a novel method of examining self-regulatory mechanisms by differentiating between uncontrolled bottom-up and goal-influenced top-down visual attention. Additionally, the method relies on naturalistic viewing instructions and procedures that limit experimental influences on viewing behavior.

2. Material and methods

2.1. Sample and participant selection

Participants were junior summer school attendants at Utrecht University and young adults recruited on the campus for monetary reward. After exclusions the final analysis included N = 80 (34 children; 46 adults). Exclusions were based on adherence to the task and data quality. Participants looking off the screen in >75% of the cases were excluded (4 adults; 18 children). Otherwise, only the respective trials were excluded (24 in adults; 28 in children). Additional exclusions were made if the root mean square noise exceeded 1° (39.5 pixels) on the screen (Holmqvist et al., 2011, p. 35 (5 trials in adults; 2 trials in children)).

52.9% of children were females with a mean age of 9.9 years (SD = 1.1). Adults included 56.5% females with a mean age of 20.4 years (SD = 2.7).

The study was conducted in accordance with the ethical standards described by the Medical Research Involving Human Subjects Act (WMO, 2012). Children's parents provided prior consent in addition to children volunteering. For the adult sample formal informed consent was obtained.

2.2. Procedure

Children and adults' eye-movements were calibrated using a 9-point calibration and were instructed to look at 4 experimental and 14 filler pictures. Exposure time was self-paced to ensure naturalistic viewing of the images (see Pieters & Wedel, 2007; Theeuwes, Atchley, & Kramer, 1998). Consequently, exposure time depended on participants' interest in the picture and terminated upon clicking the space bar (maximum = 10 s; mean for adults M = 547; SD = 250 and children M = 445; SD = 191) after which the picture disappeared. A click initiated the next trial, which started with a fixation point at the center of the screen, between the two food objects, for durations ranging from .3 to .7 s. A remote eye tracker (Eyetech TM3) was used. Gaze was recorded at a frequency of 52 Hz. This procedure was followed by a questionnaire on the importance of eating healthily.

2.3. Materials

2.3.1. Images

Photographs of one naturalistic scene of a dinner table with two opposing sets of dishes and two serving plates between the sets were presented. One serving bowl contained the unhealthy food, fried breaded meat sticks (a popular Dutch snack), and the other bowl contained the healthy food, peas (Fig. 1). Both represent commonly consumed foods in The Netherlands. The bowls on the pictures were exhibited at slightly different combinations of distances to avoid the repetition of identical pictures. Whereas previous research has shown effects of stimulus distance (Junghans, Evers, & De Ridder, 2013), differences employed here were much smaller (~10–15 cm).

2.3.2. Areas of interest

In each experimental picture two almost equally sized (maximum diversion: 4%) oval areas of interest (AOIs) were defined.

2.4. Measures

Measures of *attention attraction* were based on initial fixations and measures of *attention maintaining capacities* were based on overall dwell time (following Holmqvist et al., 2011). Initial fixations were defined as the fixation following the first fixation during onset of the image (based on an adaptive velocity threshold method; see Nyström & Holmqvist, 2010; Smeets & Hooge, 2003). Dwell time was defined as the overall amount of time that gaze was directed to an AOI.

The questionnaire examined participants' ratings of importance of eating healthily and attempt to eat healthily (1: not at all–5: very much). All participants provided demographic data.

3. Results

Comparisons of importance of healthy eating and attempts to eat healthily revealed no difference between children and adults, $t(78) = 1.48$; $p = .14$; $t(78) = -0.39$; $p = .67$.

3.1. Attention attracting capacity

Results revealed participants' tendency to look toward the left side of the computer screen in the filler images: 81.6% within adults, 76.2% within children. Consequently, the proportion of looking at the unhealthy (left) rather than the healthy food (right) in the experimental images was calculated against the proportion of looking toward the left rather than the right side of the screen. A non-parametric binomial analysis revealed a stronger tendency for both adults and children to look at the unhealthy food rather than the healthy food, compared to looking at the left rather than the right side of the screen: Adults: p = .03, Children: $p < .001$. Thus, the tendency to look toward the unhealthy food was significantly larger than the general bias toward the left side of the computer screen. Consequently, the proportion of initial fixation toward the unhealthy food was 7.9% and 14.2% higher than the proportion of initial fixations to the left side of the screen for adults and children, respectively. These findings support the first hypothesis that children and adults initially fixate on the unhealthy food to a disproportionally high degree.

Fig. 1. Sample picture with healthy and unhealthy food and their respective areas of interest.

3.2. Attention maintaining capacity

To test hypothesis two, which predicted stronger maintained attention on healthy food in adults than in children, their overall dwell time on healthy versus unhealthy food was compared. Means of the variable 'dwell time' were computed per category (healthy, unhealthy) and were natural log transformed to normalize their distribution. Outliers (+/−2 SD from the mean) were excluded. All reported means are based on untransformed data for ease of interpretation.

A multivariate ANOVA with children and adults as between subjects factor, healthiness of the food as within-subjects factor, overall dwell time on the image as covariate, and dwell time as dependent variable revealed a significant difference in dwell time on healthy and unhealthy food between children and adults, $F(2, 76) = 5.8$; $p < .01$; $\eta^2_p = .13$. Overall dwell time on the pictures was a significant covariate $F(2, 76)$, $p < .001$, $\eta^2_p = .24$. Post hoc tests showed that for the comparison of each individual food the dwell time on the unhealthy food differed significantly between adults and children ($p = .001$) whereas for healthy food no significant difference was observed ($p = .48$). While children paid more maintained attention to the unhealthy food ($M = 953$; $SD = 747$) than adults ($M = 736$; $SD = 595$), children paid equal amount of maintained attention to the healthy food ($M = 592$; $SD = 423$) as adults ($M = 717$; $SD = 505$).

Thus, adults shifted their visual attention away from the unhealthy food as time elapsed whereas children remained focused on the unhealthy food.

4. Discussion

These findings reveal differential self-regulatory avoidance tendencies in children and adults. While they report similar importance of healthy eating and attempting to eat healthily, only adults self-regulate their visual attention away from unhealthy food.

The findings show that adults are strongly attracted by unhealthy food, as revealed by unhealthy food's strong initial attention attracting capacity. However, once goal-influenced top-down processes have an influence on visual attention, adults shift their attention from the unhealthy food to the healthy food or other features on the image, suggesting a self-regulation process of avoidance. Thus, adults should be able to successfully avoid the cue-induced desire to consume the unhealthy food. Contrarily, children attend more strongly to the unhealthy food. These findings are particularly important considering the effect of endured visual attention on the increased likelihood of choosing an object (Armel, Beaumel, & Rangel, 2008) as well as the effect of an attentional food bias on craving and consumption (Castellanos et al., 2009; Jansen et al., 2003; Werthmann et al., 2014b). They are even more critical in light of the previously shown predictive power of attentional food biases on the development of overweight and obesity (Berridge, 2009; Nijs et al., 2010).

Despite not measuring actual eating behavior, the findings suggest a need for better protection of children from food cues in the environment at a young age (Nader et al., 2006).

Despite the advantages of naturalistic viewing in eye-tracking, future studies should complement this study with more controlled procedures and higher number of trials. While participants' tendency to look toward the left side of the screen could be statistically accounted for, future research should overcome this bias by mirroring images and using a counterbalancing procedure. A further limitation could be the use of self-report measures for importance of healthy eating and the impact of liking of the food on visual attention.

Overall, this study revealed adults' stronger self-regulatory avoidance of unhealthy food compared to children, thereby allowing for stronger cueing effects in children despite their goal to eating healthily. The findings call for strategies that promote children's self-regulatory skills in successfully navigating the obesogenic environment.

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Contributors

All authors and co-authors were involved in the design, analysis, and formulation of the manuscript. AFJ was involved in all stages including design, procedure, analysis, and writing. ITCH participated in the design of materials and experimental procedure of the

study as well as the analysis. JM was involved in the design and procedure, and further provided support during the formulation of the manuscript. CE and DTDD participated in the design of the study and provided feedback during the analysis and writing of the manuscript.

Conflict of interest

There were no conflicts of interest for any of the authors involved.

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