Food Quality and Preference 68 (2018) 205–214

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Adolescent emotions toward sweet food cues as a function of obesity and risky dieting practices

Laura Miccoli[a,*], Myriam Martínez-Fiestas[b,1], Rafael Delgado-Rodríguez[a,1,2], Sandra Díaz-Ferrer[a,2], Sonia Rodríguez-Ruiz[a], M. Carmen Fernández-Santaella[a]

[a] Mind, Brain, and Behavior Research Center (CIMCYC), University of Granada, Campus Universitario de Cartuja s/n, 18071 Granada, Spain
[b] Faculty of Business and Economics, University of Granada, Campus Universitario de Cartuja s/n, 18071 Granada, Spain

ARTICLE INFO

Keywords:
Adolescents
Food
Emotions
Feeding and eating disorders

ABSTRACT

This study examined whether poor health habits – those associated with a higher risk of developing eating disorders or obesity – modified adolescents' emotions toward sweet food cues. We aimed to answer the following questions: Is adolescent obesity accompanied by excessive enjoyment of sweets? Or is any risk habit, regardless its stronger association with obesity or disordered eating, associated with less food enjoyment? 552 Spanish adolescents (279 females) viewed pictures of sweets interspersed with emotional images as controls. Participants recorded their feelings of pleasure, activation, control, and food craving while looking at each picture; then answered questions on their general health, food intake, and physical activity; finally, their body mass index was estimated. We performed MANCOVAs on feelings during sweets, including individual risk habits as factors, and sex, age, and hunger as covariates. We performed the same analysis on emotional and neutral images. Results revealed that among risk habits, obesity and unhealthy dieting practices were accompanied by less enjoyment of sweets (mostly less pleasure and less food craving). On the contrary, risk habits had no effect on adolescents' feelings during emotional stimuli, unrelated to food. Thus, the presence of habits linked to obesity and disordered eating was associated with reduced reward value of sweet food cues, supporting the need to approach both disorders from an integrative perspective. Consistent with recent prevention strategies, the results suggest the potential role of food enjoyment as a protective factor.

1. Introduction

Food-related pathologies such as obesity and disordered eating are accompanied by severe health consequences that raise serious social, health, and economic concern (Brownell & Fairburn, 1995; Heymsfield & Wadden, 2017). Prevention programs worldwide aim at youth to separately address obesity and eating disorders (e.g., Ballesteros Arribas, Dal-Re Saavedra, Pérez-Farinós, & Villar Villalba, 2007; Shaw & Stice, 2016). However, some researchers (e.g., Brownell & Fairburn, 1995; Neumark-Sztainer, 2003) advocate the need for an integrated prevention of eating disorders and obesity. Several investigations that have reported an overlap between eating and weight-related disorders, overall put forward that unified prevention strategies can be more effective in the long term (e.g., Lebow, Sim, & Kransdorf, 2015; Neumark-Sztainer, 2003; Rancourt & Mccullough, 2015; Stice, Presnell, Shaw, & Rohde, 2005).

In healthy human adults, food is a natural reward that prompts a cascade of reactions that are subjectively experienced as pleasurable and physiologically coherent with the activation of a neural reward system (Kelley & Berridge, 2002). Subjective reactions to appetitive food cues are less straightforward in adults affected by disordered eating and obesity. For instance, patients diagnosed with bulimia nervosa tend to experience a decrease in food enjoyment (Rodríguez, Mata, Lameiras, Fernández-Santaella, & Vila, 2007), whereas adults with obesity tend to report excessive liking (Bartoshuk, Duffy, Hayes, Moskowitz, & Snyder, 2006). Only two studies have focused on adolescence and have observed that adolescents with obesity report less pleasure and less activation than healthy adolescents in response to appetizing food cues (Barthomeuf, Droit-Volet, & Rousset, 2009; Hofmann et al., 2016). Therefore, it remains to be investigated whether during adolescence self-imposed food restrictions are accompanied by reduced enjoyment of food. Moreover, for youth obesity, it is still not clear whether it is accompanied by increased food enjoyment, as reported in adulthood, or by decreased food enjoyment, as observed in

* Corresponding author.
E-mail address: lauramiccoli@ugr.es (L. Miccoli).
[1] MMF and RDR contributed equally to the manuscript.
[2] Present address: Department of Psychology, University of Jaén, Campus de Las Lagunillas s/n, 23071 Jaén, Spain.

https://doi.org/10.1016/j.foodqual.2018.03.006
Received 20 October 2017; Received in revised form 16 February 2018; Accepted 10 March 2018
Available online 12 March 2018
0950-3293/

the studies by Barthomeuf et al. (2009) and Hofmann et al. (2016). To our knowledge, no study have examined whether diverse risk habits modify the emotional value of food cues within an integrated perspective on eating disorders and obesity. The present work aims to investigate whether the presence of poor health habits – namely, habits associated with a higher risk of developing eating or weight-related disorders – leads to changes in adolescents' enjoyment of sweet food cues, even before the full development of food-related disorders.

For this purpose, we investigated various health habits that have been the target of Spanish obesity and eating disorder prevention strategies (López-Guimerà & Sánchez-Carracedo, 2010; Serra et al., 2007). Our interest laid in diverse habits – related to overall well-being, food intake, and physical activity – that have been shown to expose adolescents to a higher risk of suffering from eating or weight-related disorders. Due to the lack of validated instruments in Spanish by the time the data were collected, we developed a set of questions so that the adolescents could quickly complete to provide self-reported health habits. We examined shared risk factors that increased the risk of both eating disorders and obesity: smoking, constantly being on a diet, being a picky-eater, having a higher body mass index, and reporting lower self-esteem (e.g., Chiolero, Faeh, Paccaud, & Cornuz, 2008; Croll, Neumark-Szteiner, Story, & Ireland, 2002; French, Story, & Perry, 1995; Lebow et al., 2015; Neumark-Sztainer, Wall, Haines, Story, & Eisenberg, 2007). However, we were particularly interested in risk habits that were more distinctly characteristic of obesity or eating disorders. For obesity we examined skipping breakfast, sleeping less, engaging in scarce physical activity and already being obese (Ballesteros Arribas et al., 2007; Heymsfield & Wadden, 2017; Spiegel, Tasali, Penev, & Cauter, 2004). For eating disorders we examined reducing the number of meals per day and reporting unhealthy ways to lose weight– i.e., fasting the whole day, self-induced vomiting/purging, skipping meals, eating very little, not seeking professional help, and smoking to lose weight (Neumark-Sztainer, Story, Hannan, Perry, & Irving, 2002). To serve as controls for unhealthy dieters, similarly to Neumark-Sztainer et al. (2002), we examined both adolescents who never dieted (and therefore never felt the urge to diet) and adolescents who reported healthy dieting practices (and therefore felt the urge but practiced safe dieting, such as engaging in moderate physical exercise and eating more fruits and vegetable).

Methodologically, as control stimuli for sweet food cues we included emotional non-food pictures. Research on the psychophysics of taste (Bartoshuk et al., 2006) and on the neuroscience of obesity (Versace, Kypriotakis, Basen-engquist, & Schembre, 2016) advocate the inclusion of motivationally salient stimuli, unrelated to food, as control cues. Several sets of food images provide subjective emotions prompted by food cues (Blechert, Meule, Busch, & Ohla, 2014; Foroni, Pergola, Argiris, & Rumiati, 2013). Recently, our laboratory created a database of original food pictures (the Open Library of Affective Foods, OLAF) that included emotional images as controls and assessed how a large group of adolescents (Miccoli et al., 2014) and adults (Miccoli et al., 2016) felt while looking at diverse food pictures. In the original adolescent normative study, our goal was to collect and report affective ratings for the OLAF, describing in detail how food pictures were created, selected, and evaluated using the affective dimensions of pleasure/valence, activation/arousal, control/dominance, and food craving. In the current study, instead, we examined whether the affective dimensions were modulated by adolescents' risky health habits. Here, the inclusion of emotional and neutral control stimuli allowed us to infer whether adolescents' reactions were specific to food or extended to other motivationally relevant stimuli.

In summary, our goal was to investigate these alternative hypotheses: Do adolescent emotions toward sweet food cues support a unified prevention of eating disorders and obesity, so that any risk habit leads to reduced enjoyment of food cues, regardless its stronger association with obesity or disordered eating? Or do emotions toward sweet food cues diverge, so that unhealthy dieting practices are associated with reduced food enjoyment whereas habits related to obesity are accompanied by excessive enjoyment of appetizing food cues? The results, pointing out that diverse risk habits were accompanied by reduced enjoyment of sweets, are discussed in the light of the importance of approaching eating and weight-related disorders from an integrated perspective, and in the light of the possible role of food enjoyment as a protective factor.

2. Materials and methods

Data presented here were part of a study that provided adolescents' normative affective ratings of pleasure, activation, control, and food craving for a set of original food pictures (Miccoli et al., 2014). Accordingly, the procedure reported here reproduces partially the information of the normative study. The interested reader is referred to the original study for full details on food pictures creation, selection, and evaluation.

2.1. Participants

A total of 612 adolescents (11–18 years) participated in the study between October 2012 and January 2013. Data were collected by members of the research team at three public high schools, located in different neighborhoods of downtown Granada (Spain). Self-reported data were not included for 60 adolescents (9.8%) who 1) did not rate any picture in one of the affective scales; 2) rated all pictures with the same value in any of the scales; 3) withdrew from the study; 4) exceeded the age limits; or 5) were statistical outliers (see Statistical Analyses). The final sample consisted of 552 adolescents (279 females) aged 11.1 to 17.3 years (mean age 14.3 years, SD 1.4). Using G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007), a sample size of N 552 was deemed sufficient to detect small effects (Cohen's d = 0.20, $\eta^2 = 0.01$) at an alpha level of 0.05. The University of Granada Institutional Review Board approved the study (IRB# 699). All participants and their parents provided written informed consent and were informed that their responses were confidential.

2.2. Materials

2.2.1. Food and affective pictures

Each participant saw one of 4 randomized picture orders. Each order consisted of 60 pictures: 36 emotional IAPS images that were always the same and 24 OLAF food pictures that changed across orders. In each order, six out of 24 food images were sweet food cues. The 36 affective images displayed age-appropriate pleasant, neutral, and unpleasant contents and were selected from the International Affective Picture System/IAPS (Lang, Bradley, & Cuthbert, 2008). Food cues in the original normative study (Miccoli et al., 2014) consisted of low-calorie fruits and vegetables and high-calorie sweet and savory foods. The different food categories were identified after consulting with members of the Department of Nutrition and Bromatology from the University of Granada. On one extreme we identified food whose recommended frequency of consumption is high (low-calorie foods), with the further distinction between fruits and vegetables; on the other extreme, food whose recommended frequency of consumption is low (high-calorie foods), with the further distinction between sweet high-fat and salty high-fat foods. In the current investigation we focused on adolescents' emotional reactions to the images of sweet high-calorie foods (see some examples in Fig. 1), based on the greater motivational relevance of sugary food cues especially during development (Avena, Rada, & Hoebel, 2009; Birch, 1992).

2.2.2. Self-reported picture evaluations

We used the Self-Assessment Manikin/SAM (Bradley & Lang, 1994) to assess the basic affective dimensions of pleasure/valence, activation/arousal, and control/dominance. The SAM is a nonverbal pictorial scale

Fig. 1. Sweet food pictures from the OLAF catalogue. Description: Exemplars of sweet food cues from the Open Library of Affective Foods (Miccoli et al., 2014) among those that in adolescents prompted the greatest feelings of pleasure, activation, and food craving. From left to right, OLAF picture codes: sug_0152, sug_0141, and sug_4421.

used for emotional experiences toward diverse stimuli and has been successfully employed in different age groups (Ferrari, Bruno, Chattat, & Codispoti, 2016; McManis, Bradley, Berg, Cuthbert, & Lang, 2001). The SAM scale of food craving, initially developed in the context of drug addiction (Muñoz et al., 2010), was also included (see Miccoli et al., 2014).

2.2.3. Self-reported health habits

The survey, collected right after the picture-rating task, first gathered general health information, followed by food intake practices and physical activity habits.

2.2.3.1. General health information. We examined sex, age, tobacco consumption, and sleep amount. For tobacco use, adolescents reported whether they smoked (yes/no). Sleep amount (weekday time in bed) was estimated as the time (in minutes) between bedtime and rising time; afterward, we examined whether each participant's amount of sleep was age-appropriate (yes/no) based on normative data collected by the US National Sleep Foundation (Carskadon, 2011).

2.2.3.2. Food intake practices. We examined current hunger, breakfast consumption, meal frequency, picky eating, and dieting practices. For hunger (Wardle, 1987), participants rated their current level of hunger on a 1–9 Likert scale. For breakfast consumption, adolescents reported whether they had eaten breakfast on the day of the experiment (yes/no). For meal frequency, we distinguished between a healthy number (5 or 6 meals/day) and a limited number of meals (2 meals/day) (Neumark-Sztainer et al., 2002). We additionally asked adolescents whether they ate only foods that they liked ("picky eating", yes/no) (Dovey, Staples, Gibson, & Halford, 2008). Next, we investigated several healthy and unhealthy dieting practices. Throughout the survey we never used the term 'diet' but employed its definition instead –'change the way you eat so that you can lose weight'– (Neumark-Sztainer et al., 2002). Adolescents first indicated whether and how many times they dieted during the last year (i.e., "how many times during the last year have you changed the way you eat so you could lose weight?"), so that we compared adolescents who were constantly on a diet ("always trying to lose weight" or 10 or more diets/year) with adolescents who did not diet during the last year; next, we asked adolescents whether they had ever dieted in their lifetimes (yes/no), so that we identified adolescents who had never dieted; later, adolescents who dieted specified what they had done to lose weight. Based on this information, similarly to Neumark-Sztainer et al. (2002), we distinguished healthy dieting (engaging in moderate physical exercise, eating more fruits and vegetables, eating five meals a day, consulting a professional, eating less sweets) and unhealthy dieting practices (fasting the whole day, self-induced vomiting, skipping meals, eating very little, not seeking professional help, smoking to lose weight). Because adolescent dieters tended to report both healthy and unhealthy practices, we identified as "healthy dieters" only participants who reported no unhealthy dieting practice.

2.2.3.3. Physical activity habits. We examined avoiding sports and having a sedentary lifestyle. Adolescents reported whether they were involved in any sports during their out-of-school hours (yes/no) and how many hours a day they spent watching TV or playing videogames (excluding videogames involving physical activity, such as Nintendo Wii fit) (Pearson & Biddle, 2011). For sedentary behavior, we contrasted adolescents who spent an excessive amount of time (equal to or more than 3 h/day) watching TV/playing videogames with adolescents who reported minimal inactivity (less than 1 h/day).

The overall internal consistency of the survey was low (Cronbach's alpha = 0.58), indicating that the information it gathered probably referred to diverse concepts.

2.2.4. Body mass index/BMI

All participants were individually weighed on an electronic body composition analyzer (Tanita Model 300MA, Chicago, IL) and measured (to 0.1 cm on a Leicester Height Measure stadiometer) to estimate their body mass index. Next, using standardized international criteria (Cole, Bellizzi, Flegal, & Dietz, 2000; Cole, Flegal, Nicholls, Jackson, & a., 2007) we created participant BMI groups (thin, healthy, overweight, obese).

2.2.5. Level of self-esteem

Because low levels of self-esteem have been observed in both eating and weight-related disorders (Barthomeuf et al., 2009; Croll et al., 2002), adolescents' well-being was further investigated using the Spanish adaptation of the Rosenberg's Self-Esteem scale (Martín-Albo, Núñiez, Navarro, & Grijalvo, 2007). We compared picture evaluations of participants below the 1st (low self-esteem) and above the 3rd quartile (high self-esteem).

2.3. Procedure

The data were gathered during school hours at assembly halls, where adolescents sat slightly apart from each other in small groups (no more than 28 adolescents). After obtaining informed consent, the experimenters distributed booklets containing the SAM scales and the questionnaires. First, standardized instructions on the use of the SAM scales were read verbatim by one of the experimenters, using a Spanish translation of the IAPS standardized instructions for children and adolescents (Lang et al., 2008). At the beginning of the experiment, we added four practice trials, in which we displayed 4 examples of pleasant, unpleasant, sweet high-fat food, and neutral images to ensure that adolescents reached a thorough understanding of the SAM scales (IAPS No. 2340, 7950, 9908, and an original picture of a birthday cake). The SAM instructions and picture delivery were controlled using a Presentation program (v.16.3, Neurobehavioral Systems, San Francisco, CA) operated on a Toshiba Satellite ProA120 laptop. An Epson EMP-54 projector displayed the pictures on a white screen. On average, the screen subtended a visual angle of 19.32° (horizontal) × 14.72° (vertical), which was designed to maximize participants' affective reactions

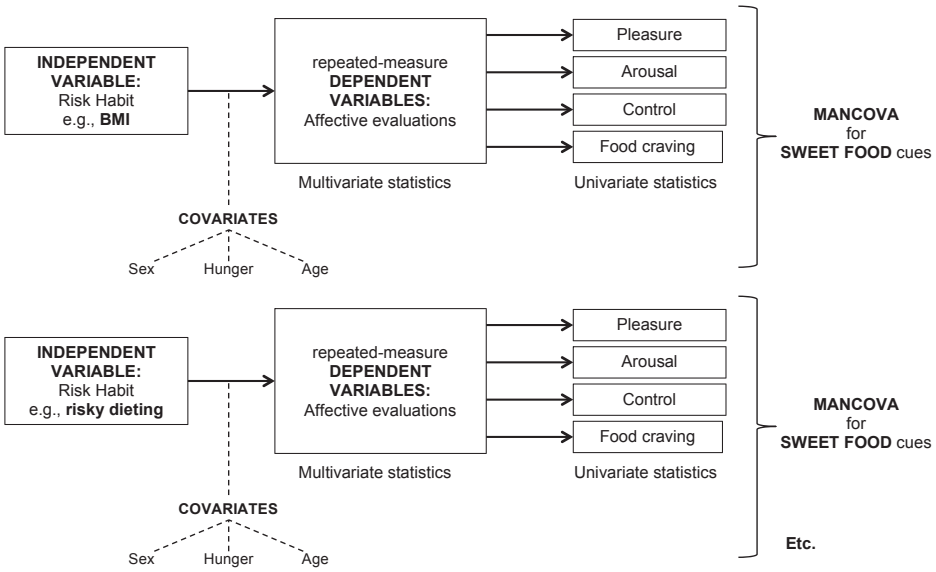

Fig. 2. Statistical design of the study. Description: For each risk factor, we examined whether its presence was associated with changes in adolescents' affective evaluations, while we controlled for possible confounders (sex, hunger, and age). Each analysis was run separately for sweet food and non-food emotional and neutral cues.

to pictures (De Cesarei & Codispoti, 2006). Each trial consisted of 4 s of preparation for the appearance of the next picture, 6 s of picture viewing, and 20 s of picture evaluation, during which adolescents had to rate how they felt while watching the picture using all SAM scales. Adolescents were invited to look at the picture the entire time that it was on the screen. The entire rating task lasted 30 min. After a small break (no longer than 10 min), during which the adolescents were allowed to stand up and/or go to the restroom, the survey on health habits and the Rosenberg's Self-Esteem scale were completed. Before leaving the conference hall, each participant's height and weight were measured to estimate his/her BMI.

2.4. Statistical analyses

All statistical analyses were performed using SPSS/Mac 20.0 (Chicago, IL, USA). Fig. 2 illustrates the statistical design of the study. We performed multivariate analyses of covariance (MANCOVA) to examine the relationship between risk habits and picture evaluations while controlling for possible confounders. In Table 1, we include the number of participants who reported or did not report the risk habit. Only risk habits that included at least 30 cases per level were entered into the analyses. Due to their heterogeneous incidence, we could not combine different risk habits into a risk profile of adolescents who implemented several unhealthy practices. Accordingly, risky health habits were introduced individually as independent factors. For each picture category (high-calorie sugar foods, pleasant, neutral, and unpleasant), the affective dimensions of pleasure, activation, control, and food craving were introduced as repeated-measure dependent variables. We included sex, age, and hunger as covariates because of their impact on eating pathologies (e.g., Neumark-Sztainer et al., 2007), affective judgments of food cues (Cooke & Wardle, 2005), and affective judgments of emotional cues (Bradley, Codispoti, Cuthbert, & Lang, 2001; Drobes et al., 2001; Ferrari et al., 2016; McManis et al., 2001). Preliminary assumption testing was conducted to check for normality, linearity, univariate/multivariate outliers, homogeneity of variance–covariance matrices, and multicollinearity (details on preliminary testing can be found in Supplementary Material 1). No serious violations were noted except for when testing for multivariate outliers. Six cases had high Mahalanobis distances and were thus excluded from the analysis. We investigated the impact of each risk factor within the multivariate analyses of covariance using Pillai's Trace. When significance in M Box's test indicated violations of the assumption of sphericity, we reported only univariate statistics. Univariate analyses of covariance provided the impact of individual risk factors on each affective dimension, thus specifying whether each risk factor modulated the feelings of pleasure, activation, control, or food craving. For all analyses, we set the level of significance to 0.05, reported Greenhouse-Geisser corrections for factors with more than two levels, and used Eta Squared/η^2 to report effect sizes – the proportion of the variance explained by the factor under study –. Although each risk factor was tested individually, we applied the Benjamini-Hochberg/B-H adjustment to protect against Familywise Error Rate inflation. Moreover, in univariate analyses, we provided 95% Šidak-adjusted confidence intervals/CIs for the mean difference between the impact of unhealthy versus healthy habits. When applicable, we corrected p levels using Šidak post hoc tests to control for multiple testing.

3. Results

Table 1 reports the average feelings of pleasure, activation, control, and craving toward sweet food cues for adolescents reporting healthy or unhealthy habits. Afterward, Table 2 outlines the statistics for risk habits associated with a significant reduction in food enjoyment (multivariate p, statistically significant dimensions based on univariate tests, estimates of mean difference between conditions [and 95% CIs], univariate F, univariate p, post hoc tests).

3.1. Risk habits and emotions during sweet food pictures

3.1.1. Among general health habits, adolescents who smoked reported less feelings of pleasure and food craving during sweet food cues than adolescent non-smokers, (multivariate test, p level close to significance after B-H adjustment: $F(4, 542) = 2.8$, $p \approx 0.05$, Pillai's Trace = 0.020, $\eta^2 = 0.020$; univariate tests: for pleasure, $F(1, 545) = 5.5$, $p < 0.05$, $\eta^2 = 0.010$, 95% CIs [−0.8, −0.07], for craving, $F(1, 545) = 4.1$, $p < 0.05$, $\eta^2 = 0.07$, 95% CIs [−1.2, −0.02]). Moreover, adolescents who did not sleep enough felt less pleasure and activation during sweets than adolescents who had sufficient sleep (multivariate test: $F(4, 531) = 3.7$, $p < 0.01$, Pillai's Trace = 0.028, $\eta^2 = 0.028$; univariate tests: for pleasure, $F(1, 534) = 7.6$, $p < 0.01$, $\eta^2 = 0.007$, 95% CIs [−0.7, −0.1], for activation, $F(1, 534) = 5.1$, $p < 0.05$, $\eta^2 = 0.009$, 95% CIs [−1.0, −0.1]).

Table 1
Average feelings of pleasure, activation, control, and craving toward sweet food cues for adolescents reporting healthy or unhealthy habits.

		n	Pleasure	Activation	Control	Craving
Smoking	No	491	7.42 (1.28)	4.36 (2.38)	6.38 (1.61)	6.21 (2.17)
	Yes	61	**6.97 (1.42)**	4.56 (2.20)	6.40 (1.62)	**5.87 (2.25)**
Insufficient sleep	No	406	7.41 (1.26)	4.44 (2.39)	6.33 (1.58)	6.19 (2.14)
	Yes	135	**7.19 (1.38)**	**4.11 (2.26)**	6.55 (1.65)	6.07 (2.35)
Skipped breakfast	No	494	7.45 (1.27)	4.46 (2.36)	6.43 (1.61)	6.25 (2.17)
	Yes	55	**6.69 (1.36)**	**3.67 (2.28)**	6.01 (1.65)	**5.52 (2.15)**
Meal frequency	5–6 meals	376	7.45 (1.29)	4.50 (2.38)	6.47 (1.58)	6.44 (2.10)
	2 meals	31	7.16 (1.34)	4.19 (2.29)	**5.77 (1.71)**	**5.54 (2.23)**
Picky eating	No	449	7.39 (1.28)	4.33 (2.34)	6.37 (1.59)	6.17 (2.18)
	Yes	100	7.30 (1.36)	4.64 (2.47)	6.44 (1.71)	6.16 (2.19)
Constant dieting[a]	No	377	7.45 (1.31)	4.48 (2.35)	6.43 (1.64)	6.36 (2.11)
	Yes	79	7.22 (1.33)	4.21 (2.36)	6.44 (1.67)	**5.63 (2.22)**
Dieting practices[b,c]	Never	286	7.50 (1.29)	4.61 (2.33)	6.46 (1.67)	6.50 (2.11)
	Healthy	86	7.49 (1.20)	4.18 (2.47)	6.42 (1.55)	6.08 (2.18)
	Risky	175	**7.10 (1.33)**	4.13 (2.37)	6.27 (1.54)	**5.73 (2.21)**
Avoiding sports	No	399	7.41 (1.30)	4.42 (2.34)	6.44 (1.60)	6.22 (2.10)
	Yes	153	**7.26 (1.29)**	4.27 (2.42)	6.26 (1.63)	6.03 (2.39)
Screen time/day	< 1 h	176	7.36 (1.32)	4.36 (2.48)	6.40 (1.50)	6.21 (2.26)
	≥ 3 h	142	7.34 (1.30)	4.21 (2.26)	6.29 (1.74)	5.95 (2.13)
BMI group	Thin	32	7.64 (1.47)	4.58 (2.39)	6.76 (1.85)	6.34 (2.35)
	Healthy	360	7.49 (1.23)	4.64 (2.35)	6.39 (1.60)	6.43 (2.07)
	Overweight	115	7.15 (1.32)	3.93 (2.28)	6.51 (1.58)	5.66 (2.27)
	Obese	45	**6.73 (1.42)**	**3.29 (2.27)**	**5.79 (1.52)**	**5.23 (2.31)**
Self-esteem[d,e]	High	153	7.45 (1.29)	4.44 (2.39)	6.60 (1.59)	6.32 (2.22)
	Low	158	**7.24 (1.36)**	4.33 (2.37)	6.39 (1.70)	5.90 (2.37)

Note:
Values indicate uncorrected means (and standard deviations).
Boldface indicates significant differences between healthy and unhealthy habits based on univariate tests.
[a] Constant dieting = always on a diet or ≥10 diets in the last year.
[b] Healthy dieting = moderate physical exercise, eating more fruits and vegetables, eating five meals a day, consulting a professional, eating less sweets;
[c] Risky dieting = fasting a whole day, vomiting, skipping meals, eating very little, not seeking professional help, smoking to lose weight.
[d] High Self-esteem = above the 3rd quartile on Rosenberg' self-esteem scale;
[e] Low Self-esteem = below the 1st quartile.

3.1.2. As for food intake practices, compared to adolescents who had breakfast on the day of the experiment, adolescents who skipped breakfast showed an overall decrease in food enjoyment (multivariate test: $F(4, 539) = 6.2$, $p < 0.001$, Pillai's Trace = 0.044, $\eta^2 = 0.044$), that was statistically significant in the dimensions of pleasure, $F(1, 542) = 23.9$, $p < 0.001$, $\eta^2 = 0.40$, 95% CIs [−1.2, −0.5], activation, $F(1, 542) = 8.1$, $p < 0.01$, $\eta^2 = 0.014$, 95% CIs [−1.6, −0.3], and food craving, $F(1, 542) = 7.7$, $p < 0.01$, $\eta^2 = 0.013$, 95% CIs [−1.4, −0.2]. Similarly, adolescents who reported risky dieting practices felt less pleasure and less food craving during sweets (multivariate test, p level close to significance after B-H adjustment: $F(8, 1074) = 2.6$, $p \approx 0.05$, Pillai's Trace = 0.033, $\eta^2 = 0.017$; univariate tests: for pleasure, $F(2, 539) = 6.6$, $p < 0.01$, $\eta^2 = 0.023$, for food craving, $F(2, 539) = 5.1$, $p < 0.01$, $\eta^2 = 0.017$). Post hoc Šidak tests revealed that risky dieters felt less pleasure than healthy dieters ($p < 0.05$, 95% CIs [−0.8, −0.01]) and less pleasure and less craving than adolescents who had never dieted ($p < 0.01$, 95% CIs [−7.4, −0.1]; $p < 0.01$, 95% CIs [−1.1, −0.1], respectively). Notably, feelings toward sweet food cues of adolescents who reported healthy dieting practices did not differ from the feelings of adolescents who had never dieted.

Based on multivariate tests, meal frequency, picky eating, and being constantly on a diet had no impact on feelings during sweets. However, univariate tests indicated that adolescents who had 2 meals/day felt less in control ($F(1, 400) = 4.8$, $p < 0.05$, $\eta^2 = 0.012$, 95% CIs [−1.2, −0.07]) and reported less craving ($F(1, 400) = 3.9$, $p < 0.05$, $\eta^2 = 0.010$, 95% CIs [−1.5, −0.002]) than adolescents who had 5–6 meals/day. Moreover, adolescents who were constantly on a diet reported reduced food craving ($F(1, 450) = 7.2$, $p < 0.01$, $\eta^2 = 0.014$, 95% CIs [−1.2, −0.2]) compared to adolescents who did not diet during the past year.

3.1.3. Overall, multivariate tests showed that physical activity practices (avoiding sport or reporting excessive screen time/day) had no impact on food enjoyment. However, univariate statistics revealed that adolescents who avoided sport tended to report less pleasure during sweets than adolescents involved in sport, $F(1, 545) = 4.9$, $p < 0.05$, $\eta^2 = 0.008$, 95% CIs [−0.5, −0.02].

3.1.4. Belonging to a given BMI group, namely being obese, was associated with a significant decrease in food enjoyment (multivariate test: $F(12, 1626) = 2.3$, $p < 0.01$, Pillai's Trace = 0.051, $\eta^2 = 0.017$), that was visible in all affective dimensions: pleasure $F(3, 543) = 5.3$, $p < 0.001$, $\eta^2 = 0.027$, activation $F(3, 543) = 4.0$, $p < 0.01$, $\eta^2 = 0.020$, control $F(3, 543) = 3.0$, $p < 0.05$, $\eta^2 = 0.016$, and craving $F(3, 543) = 4.2$, $p < 0.01$, $\eta^2 = 0.020$. Post hoc Šidak tests indicated that, when looking at sweet food cues, adolescents with obesity felt less pleasure ($p < 0.01$, 95% CIs [−1.3, −0.2]), less activation ($p < 0.05$, 95% CIs [−2.0, −0.1]), and less food craving ($p < 0.05$, 95% CIs [−1.8, −0.05]) than adolescents with a healthy weight. Moreover, adolescents with obesity felt less pleasure than adolescents with low weight ($p < 0.05$, 95% CIs [−1.6, −0.09]) and less control than adolescents with overweight ($p < 0.05$, 95% CIs [−1.5, −0.01]).

3.1.5. Finally, univariate statistics indicated that adolescents with low self-esteem reported, compared to adolescents with high self-esteem, less pleasure during sweets, $F(1, 305) = 5.5$, $p < 0.05$, $\eta^2 = 0.016$, 95% CIs [−0.7, −0.06]. Additional Pearson Chi Square tests showed no correlation between having low self-esteem and

belonging to any specific BMI group. However, the level of self-esteem did correlate with risky dieting practices, so that among adolescents who reported risky dieting practices (97), 74.2% (72) had low self-esteem, whereas among adolescents who had never dieted (167), 61% (103) had high self-esteem.

As a whole, multivariate and univariate statistics indicated that diverse unhealthy habits were associated with a decrease in food enjoyment. Such reduction was observed more often in the affective dimensions of pleasure and food craving.

3.2. Risk habits and emotions during emotional and neutral pictures

Risk habits were associated with no changes in emotions during control pictures, regardless their emotional or neutral content[3]. A few risk habits (constant dieting, avoiding sport, having a higher BMI) were associated with minor changes in emotions during control pictures, however theses changes were statistically not significant after applying the Benjamini-Hochberg correction to FWER. Moreover, significance in M-Box and Levene tests for these factors indicated that the results were negligible based on violations of the assumptions of sphericity and of homogeneity of variance. Full details are included as Supplementary Material 2.

4. Discussion

The data revealed a consistent pattern, suggesting that a wide range of habits that exposed adolescents to a higher risk of eating disorders and obesity were accompanied by limited enjoyment of high-calorie sugary foods. Therefore, in line with the initial hypothesis that risk habits lead to reduced enjoyment of food, regardless their stronger association with obesity or disordered eating, adolescents' emotions toward sweet food cues supported a unified prevention of eating disorders and obesity. Unhealthy practices that led to blunted food enjoyment were diverse and included habits clearly related to food, such as having a higher body mass index or deliberately restricting food intake (by skipping breakfast, reducing meal frequency, constantly dieting or using unhealthy dieting practices), as well as habits with a less straightforward relation with food, such as failing to adhere to basic health practices (smoking, insufficient sleep). Overall, BMI and food restrictions had a stable impact on emotions during sweet food cues, leading to a decrease especially in subjective pleasure and food craving. Conversely, lack of physical activity (as measured by a lack of engagement in sport and spending an important part of the day on sedentary activities) did not influence feelings toward sweets. Thus, BMI and dieting had a similar impact on adolescents' emotions, whereas physical activity had no impact on feelings during sugary food cues. These results bring to mind previous findings (e.g., Neumark-Sztainer et al., 2007; Stice et al., 2005) that suggest that dieting is a stronger predictor of later development of obesity than scarce physical activity and negative affect. Our data further confirm the importance of approaching food-related disorders from an integrated perspective.

Although our findings were consistent with previous data (Barthomeuf et al., 2009; Hofmann et al., 2016), above all, it was surprising to observe that adolescents with obesity felt worse, less activated, and less craving than healthy controls when looking at high-calorie foods. In this study we controlled for some methodological factors that, as noted by Hofmann et al. (2016), could have affected the results they observed, such as age and sample provenance (in their study, adolescents recruited from obesity clinics might have been more aware of the health hazards related to high-calorie foods). Therefore, we similarly considered alternative explanations for our findings. First, we considered the possibility that the adolescents' evaluations were not reliable (Brener, Billy, & Grady, 2003). However, adolescents' affective reactions to emotional images (Miccoli et al., 2014) were consistent with the literature (McManis et al., 2001) and confirmed adolescents' understanding of the scales. The use of emotional stimuli unrelated to food as control stimuli, additionally addressed individual variability in the relevance attributed to food cues (Bartoshuk et al., 2006), thus promoting the reliability of the food cue evaluations obtained. The inclusion of pleasant content unrelated to food (babies, families, adventure scenes) further allowed us to observe that pleasant stimuli other than foods were unaffected by the presence of risk habits. We could not, however, exclude the main alternative explanation that social pressure in the form of social desirability bias could have kept some subgroups of participants from revealing the excessive importance they assigned to sugary food cues. However, in this context, it seems significant that some authors have hypothesized that adherence to social norms (Leachman Slawson et al., 2015), particularly in the form of fear of negative social evaluations (Levinson & Rodebaugh, 2015), might represent a common substrate that facilitates the growth of both eating disorders and excessive food intake. We can therefore hypothesize that our data might reflect this shared vulnerability.

In the case of obesity, both individual factors – such as food restraint, loss of control over food intake, and the need to renounce food pleasure for the sake of health (Barthomeuf et al., 2009; Stroebe, Van Koningsbruggen, Papies, & Aarts, 2013) – as well as social factors – such as peer pressure and the powerful social stigma against obesity (Schupp & Renner, 2011; Westermann, Rief, Euteneuer, & Kohlmann, 2015) – could lead adolescents with obesity to associate unpleasant feelings with appetitive food cues. In adulthood, researchers who investigated physiological brain reactions in obesity detected both hyper-reactivity and hypo-reactivity after exposure to food cues (for a review, see Burger & Stice, 2011). Accordingly, some authors have hypothesized 1) that individuals with obesity are a heterogeneous group, and thus hyper- and hypo-reactivity to food cues might depend on the simultaneous presence of binge eating (Dalton & Finlayson, 2014) or, in the absence of binge eating, on the rewarding value personally assigned to food cues (Hofmann et al., 2016; Versace et al., 2016) and 2) that brain hyper-reactivity and hypo-reactivity might both be present in individuals at risk for obesity, changing over time as a result of overeating and fat accumulation (Burger & Stice, 2011).

In children and in adults, reduced pleasure and reduced food craving can emerge also after weight loss, restrictive diets, and bariatric surgery (e.g., Howe, Mandic, Parnell, & Skidmore, 2012; Pepino, Stein, Eagon, & Klein, 2014). In our data, moderate food restrictions led to a decrease in the enjoyment of food, thus confirming that during adolescence seemingly trivial restrictions should prompt alert in health care providers, even more so in the presence of overweight or obesity (Lebow et al., 2015). It must be noted, however, that in the studies cited above, the reduction in food enjoyment was considered an encouraging correlate of weight loss interventions, as an index of a decrease in the

[3] A MANOVA test, as compared to an ANOVA, always reduces the probability of committing type I errors. To further reduce the possibility of FWER inflation, we applied the Benjamini-Hochberg correction. In each MANCOVA, we included as repeated-measure dependent variable the different affective dimensions (pleasure, activation, control, and craving), because they were somewhat correlated, although without reaching multicollinearity (Supplementary Material 1). The reasons for not including as dependent variable the different picture categories (sweets, pleasant, neutral, unpleasant) were threefold: 1) It would not have been appropriate because of low/not significant cross-correlations between the different picture categories (idem). 2) In case of significant multivariate test for a certain risk habit, we could not have disentangled which picture category prompted statistical significance. 3) Our main goal was to investigate whether risk vs. healthy habits modulated adolescents' emotions toward sweet food cues, whereas emotions evoked by the different picture categories were investigated and contrasted in our 2014 publication. However, to further test the existence of different patterns of emotions when adolescents looked at sweets rather than emotional pleasant cues, we introduced each risk factor into a two-way repeated-measure ANCOVA on the affective dimensions (4 levels: pleasure, activation, control, and craving) for sweet and pleasant picture categories (2 levels), while we included sex, age, and hunger as covariates. We specifically tested the presence of significant two-way interactions between habit (healthy vs. risky) and picture content (sweets vs. pleasant). Risk habits that in the paper are reported as statistically significant were equally significant in the two-way interactions, confirming the existence of different patterns in sweets and pleasant cues as a function of risk vs. healthy habits.

Table 2
Adjusted statistics and estimates [95% Confidence Intervals] for unhealthy habits associated with less food enjoyment.

	Multivariate p	Univariate dimension	Estimates [and 95% CIs]	Univariate F	Univariate p
Smoking	≈0.05*	pleasure	−0.42 [−0.8, −0.07]	5.5	< 0.05
		craving	−0.59 [−1.1, −0.02]	4.1	< 0.05
Insufficient sleep	< 0.01	pleasure	−0.35 [−0.7, −0.1]	7.6	< 0.01
		activation	−0.52 [−1.0, 0.1]	5.1	< 0.05
Skipped breakfast	< 0.001	pleasure	−0.88 [−1.2, −0.5]	23.9	< 0.001
		activation	−0.93 [−1.6, −0.3]	8.1	< 0.01
		craving	−0.82 [−1.4, −0.2]	7.7	< 0.01
Low meal frequency	n.s.	control	−0.65 [−1.2, −0.07]	4.8	< 0.05
		craving	−0.75 [−1.5, −0.01]	3.9	< 0.05
Constant dieting	n.s.	craving	−0.69[a] [−1.2, −0.2]	7.2	< 0.01
Risky dieting	≈0.05*	pleasure	−0.40[b] [−0.8, −0.01] −0.44[c] [−7.4, −0.1]	6.6	< 0.01
		craving	−0.64[c] [−1.1, −0.1]	5.1	< 0.01
Avoiding sports	n.s.	pleasure	−0.27 [−0.5, −0.02]	4.5	< 0.05
BMI group	< 0.01	pleasure	−0.73[d] [−1.3, −0.2] −0.87[e] [−1.6, −0.09]	5.3	< 0.001
		activation	−1.1[d] [−2.0, −0.1]	4.0	< 0.01
		control	−0.76[f] [−1.5, −0.01]	3.0	< 0.05
		craving	−0.93[d] [−1.8, −0.05]	4.2	< 0.01
Low self-esteem	n.s.	pleasure	−0.36 [−0.66, −0.06]	5.5	< 0.05

Notes. Multivariate and univariate statistics for risk habits that were associated with a reduction in food enjoyment in any of the affective dimensions.
Asterisks denote p levels that were close to significance after applying the Benjamini-Hochberg/B-H correction to the Familywise Error Rate (FWER). Using the B-H correction, each p level remains the same, but is regarded as significant or not based on the B-H cutoff p value, computed for that specific contrast. Accordingly, for 'smoking' p = 0.027 with B-H cutoff at p = 0.023; for 'risky dieting' p = 0.022 with B-H cutoff at p = 0.018.
Subscript letters indicate statistically significant comparisons between:
[a] Adolescents who were constantly on a diet and adolescents who did not diet during the last year.
[b] Adolescents who reported risky rather than healthy dieting practices (Šidak-adjusted).
[c] Adolescents who reported risky dieting practices and adolescents who never dieted (Šidak-adjusted).
[d] Adolescents with obesity and adolescents with a healthy weight (Šidak-adjusted).
[e] Adolescents with obesity and adolescents with low weight (Šidak-adjusted).
[f] Adolescents with obesity and adolescents with overweight (Šidak-adjusted).

motivational relevance of food. In contrast, in our data, food enjoyment signaled a healthy relationship with food, whereas decreased enjoyment was a consequence of risky health habits. This is probably the most relevant finding of our study: decreased pleasure from sweet food cues in adolescents with obesity and self-reported dieting. Obesity interventions generally aim to increase health information to decrease overeating, thus attempting to circumvent food pleasure by reinforcing alternative self-regulation strategies for the purpose of good health (e.g., Stroebe et al., 2013). Researchers proposing an integrated perspective on obesity and eating disorders (e.g., Brownell & Fairburn, 1995; Neumark-Sztainer, 2003) have emphasized that in contrast with its purposes, this regulation is precisely where obesity prevention strategies can pave the way for disordered eating, by promoting restraint while yielding only occasionally to pleasure. However, adults and children find it difficult to renounce the pleasure associated with unhealthy foods (Carrete & Arroyo, 2014), which is precisely the target of food marketing strategies (Pettigrew, 2016). Considering these findings, some researchers have recently proposed alternative approaches to promoting healthy eating (Cornil & Chandon, 2016a; Pettigrew, 2016) that focus precisely on food pleasure "as an ally of healthy eating" instead of attempting to avoid it. The rationale is that the orosensory pleasure associated with food (food enjoyment) peaks in the first bites and then decays, and thus food enjoyment does not increase with portion size. The authors further proposed (Cornil & Chandon, 2016b) that focusing on food pleasure could ultimately render obesity interventions more successful, by promoting moderate food intake without renouncing pleasure. In the same line, recent reviews (Marty, Chambaron, Nicklaus, & Monnery-Patris, 2018) point out

that promoting healthy eating among children by focusing on food pleasure, could be more successful than by providing nutritional information on 'good' and 'bad food', that has shown limited outcomes. Some local health interventions have concentrated on food pleasure in elderly individuals (e.g., Mathey, Siebelink, de Graaf, & Van Staveren, 2001) and children (e.g., van der Horst, 2012), and the European Union has recently funded some larger-scale pilot projects ("We love eating"; "My healthy family") to promote healthy eating by targeting food pleasure. Our data repeatedly show that healthy practices are associated with greater food pleasure, whereas diverse unhealthy practices, regardless their stronger association with obesity or disordered eating, are accompanied by reduced food enjoyment. The findings, as a whole, support the relevance of food enjoyment in adolescents' relationship with food, further suggesting its potential as a protective factor against the development of eating and weight-related disorders.

Emotion literature shows that control/dominance highly correlates with pleasure, but becomes informative in clinical populations. For instance, patients diagnosed with specific phobias and bulimia nervosa feel less in control when exposed to cues related to their disorder (Bradley & Lang, 2007; Rodríguez et al., 2007). In our adolescent sample, however, control dissociated from pleasure and was essentially unaffected by risk habits. Future studies might investigate whether reduced feelings of control toward appetitive food cues emerge only as a result of severe and prolonged altered food intake.

Activation/arousal refers to the intensity of the emotion evoked by the stimuli (Bradley & Lang, 2007). The reduction in activation as a result of risk habits was less pronounced than that observed for pleasure and food craving. Such reduction was mostly observed for habits that had a pervasive impact on emotions toward sweets (being obese, having skipped breakfast), overall suggesting that the intensity of the feelings toward sweet food cues was mostly an indistinct correlate of emotional processing and that activation was overall scarcely affected by the presence of risk habits.

4.1. Limitations and strengths

We acknowledge several limitations to the study. The main drawback was not using a validated instrument to assess adolescents' diverse risk and healthy habits. Nevertheless, probed habits and behaviors were relevant because they are investigated among those that might lead to eating disorders and obesity. Although the size of the sample was satisfactory, the limited number of adolescents simultaneously involved in diverse unhealthy practices did not allow us to perform analyses on the combined effect of different risk habits. We relied therefore on statistical methods to control that the findings were not spurious. Future studies could investigate how obesity- and eating disorder-related practices might interact with each other to identify a shared risk profile. Another limitation relates to the assessment of some risk habits –for example, "picky eating", defined as the tendency to eat only a very limited variety of foods and to resist trying new foods- since it may be biased by the specific wording of the question asked -"do you eat only what you like?". This simplification may not cover all aspects of the risk habit being assessed (Dovey et al., 2008).

Despite these limitations, and considering the key role of pleasure in food choice (Jacquier, Bonthoux, Baciu, & Ruffieux, 2012) and, in turn, in the development of unhealthy eating practices, it is surprising the scarce number of studies examining adolescents' emotional reactions to food cues as a function of the presence of obesity or eating disorder-related risk habits. From a theoretical point of view, the present investigation provides a relevant contribution because it encompasses habits that expose adolescents to a higher risk of obesity and eating disorders, thus examining the impact of risk factors from a broader, more integrated perspective. From a methodological point of view, the sample of adolescents being studied was wide and heterogeneous, i.e., not recruited from obesity or eating disorder clinics, and it could therefore sufficiently represent the general population. Moreover, the current research used emotional pictures as non-food controls. The inclusion of affective images allowed us to control for adolescents' adequate understanding of the SAM scales and to ensure that the food evaluations were reliable. Most importantly, it provided proper control stimuli to reliably infer the motivational relevance of food cues (Versace & Schembre, 2015).

4.2. Conclusions

Current epidemiological research has provided accumulating evidence that risk factors for eating disorders and obesity tend to overlap[4]. The present work examined the consequences of these risk factors on adolescents' feelings toward sweet food cues. The findings indicated that risk habits, regardless their association with obesity or disordered eating, were consistently accompanied by an early decrease in food enjoyment. Overall, our data support the need to approach eating and weight-related disorders from an integrated perspective that focuses on adolescence as a time when shared vulnerabilities expose individuals to a higher risk of food-related disorders.

Acknowledgments

This work was supported by a grant from Junta de Andalucía, Spain (grant code P12.SEJ.391). The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. The authors wish to thank: the adolescents, their families, and the professors for participating in the study; Jaime Vila, Leandro L. Di Stasi, and two anonymous reviewers for their comments on earlier versions of the manuscript; Sara Coca, Enrique Muñoz de Escalona, and Eduardo García-Marmol for helping with data collection.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.foodqual.2018.03.006.

References

Avena, N. M., Rada, P., & Hoebel, B. G. (2009). Sugar and fat bingeing have notable differences in addictive-like behavior. *The Journal of Nutrition, 139*(3), 623–628. http://dx.doi.org/10.3945/jn.108.097584.

Ballesteros Arribas, J. M., Dal-Re Saavedra, M., Pérez-Farinós, N., & Villar Villalba, C. (2007). La estrategia para la nutrición, actividad física y prevención de la obesidad (estrategia NAOS). *Revista Española de Salud Pública,* 443–449.

Barthomeuf, L., Droit-Volet, S., & Rousset, S. (2009). Obesity and emotions: Differentiation in emotions felt towards food between obese, overweight and normal-weight adolescents. *Food Quality and Preference, 20*(1), 62–68. http://dx.doi.org/10.1016/j.foodqual.2008.07.005.

Bartoshuk, L. M., Duffy, V. B., Hayes, J. E., Moskowitz, H. R., & Snyder, D. J. (2006). Psychophysics of sweet and fat perception in obesity: Problems, solutions and new perspectives. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 361*(1471), 1137–1148. http://dx.doi.org/10.1098/rstb.2006.1853.

Birch, L. (1992). Children's preferences for high-fat foods. *Nutrition Reviews, 50*(9), 249–255.

Blechert, J., Meule, A., Busch, N. A., & Ohla, K. (2014). Food-pics: An image database for experimental research on eating and appetite. *Frontiers in Psychology, 5*, 617. http://dx.doi.org/10.3389/fpsyg.2014.00617.

Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing. *Emotion, 1*(3), 276–298. http://dx.doi.org/10.1037//1528-3542.1.3.276.

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment Manikin and the semantic differential. *Journal of Therapy and Experimental Psychiatry, 25*(I), 45–59.

Bradley, M., & Lang, P. J. (2007). The international affective picture system (IAPS) in the study of emotion and attention. In J. A. Coan, & J. J. B. Allen (Eds.). *Handbook of emotion elicitation and assessment* (pp. 29–46). Oxford University Press.

Brener, N. D., Billy, J. O., & Grady, W. R. (2003). Assessment of factors affecting the

[4] For instance, sleep deprivation, which was earlier associated with a higher risk of developing obesity, has recently been found to lead also to a worse prognosis in eating disorders (Lombardo, Battagliese, Venezia, & Salvemini, 2015)

validity of self-reported health-risk behavior among adolescents: Evidence from the scientific literature. *Journal of Adolescent Health, 33*(6), 436–457. http://dx.doi.org/10.1016/S1054-139X(03)00052-1.

Brownell, K. D., & Fairburn, C. G. (1995). *Eating disorders and obesity: A comprehensive handbook.* New York: Guilford Press.

Burger, K., & Stice, E. (2011). Variability in reward responsivity and obesity: Evidence from brain imaging studies. *Current Drug Abuse Reviews, 4*(3), 182–189.

Carrete, L., & Arroyo, P. (2014). Insights from a qualitative study in Mexico Social marketing to improve healthy dietary decisions. *Qualitative Market Research: An International Journal, 17*(3), 239–263. http://dx.doi.org/10.1108/QMR-11-2011-0023.

Carskadon, M. A. (2011). Sleep in adolescents: The perfect storm. *Pediatrics Clinics of North America, 72*(2), 181–204. http://dx.doi.org/10.1038/nature13314.A.

Chiolero, A., Faeh, D., Paccaud, F., & Cornuz, J. (2008). Consequences of smoking for body weight, body fat distribution, and insulin resistance. *The American Journal of Clinical Nutrition, 87*, 801–809.

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ, 320*(May), 1–6. http://dx.doi.org/10.1136/bmj.320.7244.1240.

Cole, T. J., Flegal, K. M., Nicholls, D., Jackson, A., & a. (2007). Body mass index cut offs to define thinness in children and adolescents: International survey. *BMJ (Clinical Research Ed.), 335*, 194. http://dx.doi.org/10.1136/bmj.39238.399444.55.

Cooke, L. J., & Wardle, J. (2005). Age and gender differences in children's food preferences. *The British Journal of Nutrition, 93*(5), 741–746. http://dx.doi.org/10.1079/bjn20051389.

Cornil, Y., & Chandon, P. (2016b). Pleasure as an ally of healthy eating? Contrasting visceral and Epicurean eating pleasure and their association with portion size preferences and wellbeing. *Appetite, 104*, 52–59.

Cornil, Y., & Chandon, P. (2016a). Pleasure as a substitute for size: How multisensory imagery can make people happier with smaller food portions. *Journal of Marketing Research, LIII*(October), 847–864. http://dx.doi.org/10.1509/jmr.14.0299.

Croll, J., Neumark-Szteiner, D., Story, M. T., & Ireland, M. (2002). Prevalence and risk and protective factors related to disordered eating behaviors among adolescents: Relationship to gender and ethnicity. *Journal of Adolescent Health, 31*(2), 166–175. http://dx.doi.org/10.1016/S1054-139X(02)00368-3.

Dalton, M., & Finlayson, G. (2014). Psychobiological examination of liking and wanting for fat and sweet taste in trait binge eating females. *Physiology & Behavior, 136*, 128–134.

De Cesarei, A., & Codispoti, M. (2006). When does size not matter? Effects of stimulus size on affective modulation. *Psychophysiology, 43*(2), 207–215. http://dx.doi.org/10.1111/j.1469-8986.2006.00392.x.

Dovey, T. M., Staples, P. A., Gibson, E. L., & Halford, J. C. G. (2008). Food neophobia and "picky/fussy" eating in children: A review. *Appetite, 50*(2–3), 181–193. http://dx.doi.org/10.1016/j.appet.2007.09.009.

Drobes, D. J., Miller, E. J., Hillman, C. H., Bradley, M. M., Cuthbert, B. N., & Lang, P. J. (2001). Food deprivation and emotional reactions to food cues: Implications for eating disorders. *Biological Psychology, 57*, 153–177.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191.

Ferrari, V., Bruno, N., Chattat, R., & Codispoti, M. (2016). Evaluative ratings and attention across the life span: Emotional arousal and gender. *Cognition and Emotion,* 1–12.

Foroni, F., Pergola, G., Argiris, G., & Rumiati, R. I. (2013). The FoodCast research image database (FRIDa). *Frontiers in Human Neuroscience, 7*(March), 51. http://dx.doi.org/10.3389/fnhum.2013.00051.

French, S. A., Story, M., & Perry, C. L. (1995). Self-esteem and obesity in children and adolescents: A literature review. *Obesity Research, 3*(5), 479–490.

Heymsfield, S. B., & Wadden, T. A. (2017). Mechanisms, pathophysiology, and management of obesity. *The New England Journal of Medicine, 376*(3), 254–266. http://dx.doi.org/10.1056/NEJMra1514009.

Hofmann, J., Meule, A., Reichenberger, J., Weghuber, D., Ardelt-Gattinger, E., & Blechert, J. (2016). Crave, Like, Eat: Determinants of food intake in a sample of children and adolescents with a wide range in body mass. *Frontiers in Psychology, 7*(September), 1–9. http://dx.doi.org/10.3389/fpsyg.2016.01389.

Howe, A. S., Mandic, S., Parnell, W. R., & Skidmore, P. M. L. (2012). Attitudes to food differ between adolescent dieters and non-dieters from Otago, New Zealand, but overall food intake does not. *Public Health Nutrition, 16*(1), 36–45. http://dx.doi.org/10.1017/S1368980012001152.

Jacquier, C., Bonthoux, F., Baciu, M., & Ruffieux, B. (2012). Improving the effectiveness of nutritional information policies: Assessment of unconscious pleasure mechanisms involved in food-choice decisions. *Nutrition Reviews, 70*(2), 118–131. http://dx.doi.org/10.1111/j.1753-4887.2011.00447.x.

Kelley, A., & Berridge, K. (2002). The Neuroscience of natural rewards: relevance to addictive drugs. *Journal of Neuroscience, 22*(9), 3306–3311.

Lang, P., Bradley, M., & Cuthbert, B. (2008). *International Affective Picture System (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8.* Gainesville, FL: University of Florida.

Leachman Slawson, D., Dalton, W. T., III, Mckeehan Dula, T., Southerland, J., Wang, L., Littleton, M. A., ... Wu, T. (2015). College students as facilitators in reducing adolescent obesity disparity in Southern Appalachia: Team up for healthy living. *Contemporary Clinical Trials, 43*, 39–52. http://dx.doi.org/10.1016/j.cct.2015.04.012.

Lebow, J., Sim, L. A., & Kransdorf, L. N. (2015). Prevalence of a history of overweight and obesity in adolescents with restrictive eating disorders. *Journal of Adolescent Health, 56*(1), 19–24. http://dx.doi.org/10.1016/j.jadohealth.2014.06.005.

Levinson, C. A., & Rodebaugh, T. L. (2015). Negative social-evaluative fears produce social anxiety, food intake, and body dissatisfaction: Evidence of similar mechanisms through different pathways clinical. *Clinical Psychological Science, 3*(5), 744–757. http://dx.doi.org/10.1177/2167702614548891.

Lombardo, C., Battagliese, G., Venezia, C., & Salvemini, V. (2015). Eating behaviors persistence of poor sleep predicts the severity of the clinical condition after 6 months of standard treatment in patients with eating disorders. *Eating Behaviors, 18*(March), 16–19. http://dx.doi.org/10.1016/j.eatbeh.2015.03.003.

López-Guimerà, G., & Sánchez-Carracedo, D. (2010). *Prevención de las alteraciones alimentarias: Fundamentos teóricos y recursos prácticos.* Madrid, Spain: Pirámide.

Martín-Albo, J., Núñiez, J. L., Navarro, J. G., & Grijalvo, F. (2007). The Rosenberg self-esteem scale: Translation and validation in university students. *The Spanish Journal of Psychology, 10*(2), 458–467.

Marty, L., Chambaron, S., Nicklaus, S., & Monnery-Patris, S. (2018). Learned pleasure from eating: An opportunity to promote healthy eating in children? *Appetite, 120*, 265–274. http://dx.doi.org/10.1016/j.appet.2017.09.006.

Mathey, M.-F., Siebelink, E., de Graaf, C., & Van Staveren, W. A. (2001). Flavor enhancement of food improves dietary intake and nutritional status of elderly nursing home residents. *Journal of Gerontology, 56*(4), 200–205.

McManis, M. H., Bradley, M. M., Berg, W. K., Cuthbert, B. N., & Lang, P. J. (2001). Emotional reactions in children: verbal, physiological, and behavioral responses to affective pictures. *Psychophysiology, 38*, 222–231. http://dx.doi.org/10.1017/S0048577201991140.

Miccoli, L., Delgado, R., Guerra, P., Versace, F., Rodríguez-Ruiz, S., & Fernández-Santaella, M. C. (2016). Affective pictures and the open library of affective foods (OLAF): Tools to investigate emotions toward food in adults. *PLoS One, 1–13*. http://dx.doi.org/10.1371/journal.pone.0158991.

Miccoli, L., Delgado, R., Rodríguez-Ruiz, S., Guerra, P., García-Mármol, E., & Fernández-Santaella, M. C. (2014). Meet OLAF, a good friend of the IAPS! The open library of affective foods: A tool to investigate the emotional impact of food in adolescents. *PLoS One, 9*(12), e114515. http://dx.doi.org/10.1371/journal.pone.0114515.

Muñoz, M.Á., Viedma-del-Jesus, M. I., Fernández-Santaella, M. C., Peralta-Ramírez, M. I., Cepeda-Benito, A., & Vila, J. (2010). Assessment of tobacco craving by means of the affective image visualization paradigm. *Motivation and Emotion, 34*(1), 93–103. http://dx.doi.org/10.1007/s11031-009-9145-1.

Neumark-Sztainer, D. R. (2003). Obesity and eating disorder prevention: An integrated approach? *Adolescent Medicine, 14*(1), 159–173.

Neumark-Sztainer, D., Story, M., Hannan, P., Perry, C., & Irving, L. (2002). Weight-related concerns and behaviors among overweight and nonoverweight adolescents: Implications for preventing weight-related disorders. *Archives of Pediatrics & Adolescent Medicine, 156*(2), 171–178. http://dx.doi.org/10.1001/archpedi.156.2.171.

Neumark-Sztainer, D. R., Wall, M., Haines, J., Story, M., & Eisenberg, M. E. (2007). Why does dieting predict weight gain in adolescents? Findings from project EAT-II: A 5-year longitudinal study. *Journal of the American Dietetic Association, 107*(3), 448–455. http://dx.doi.org/10.1016/j.jada.2006.12.013.

Neumark-Sztainer, D. R., Wall, M. M., Haines, J. I., Story, M. T., Sherwood, N. E., & van den Berg, P. A. (2007). Shared risk and protective factors for overweight and disordered eating in adolescents. *American Journal of Preventive Medicine, 33*(5), 359–369. http://dx.doi.org/10.1016/j.amepre.2007.07.031.

Pearson, N., & Biddle, S. J. H. (2011). Sedentary behavior and dietary intake in children, adolescents, and adults: A systematic review. *American Journal of Preventive Medicine, 41*(2), 178–188. http://dx.doi.org/10.1016/j.amepre.2011.05.002.

Pepino, M. Y., Stein, R. I., Eagon, J. C., & Klein, S. (2014). Bariatric surgery-induced weight loss causes remission of food addiction in extreme obesity. *Obesity, 22*(8), 1792–1798. http://dx.doi.org/10.1002/oby.20797.

Pettigrew, S. (2016). Pleasure: An under-utilised "P" in social marketing for healthy eating. *Appetite, 104*, 60–69. http://dx.doi.org/10.1016/j.appet.2015.10.004.

Rancourt, D., & Mccullough, M. B. (2015). Overlap in eating disorders and obesity in adolescence. *Current Diabetes Report, 15*(10), 1–9. http://dx.doi.org/10.1007/s11892-015-0645-y.

Rodríguez, S., Mata, J. L., Lameiras, M., Fernández-Santaella, M. C., & Vila, J. (2007). Dyscontrol evoked by erotic and food images in women with bulimia nervosa. *European Eating Disorders Review, 15*, 231–239.

Schupp, H. T., & Renner, B. (2011). The implicit nature of the anti-fat bias. *Frontiers in Human Neuroscience, 5*(March), 1–11. http://dx.doi.org/10.3389/fnhum.2011.00023.

Serra, J. D., Franch, A. A., Lopez, L. G., Costa, C. M., Salinas, C. S., & Cortina, L. S. (2007). Obesidad Infantil. Recomendaciones del Comité de Nutrición de la Asociación Española de Pediatría. Parte II. Diagnóstico. Comorbilidades. Tratamiento. *Anales de Pediatría, 66*(3), 294–304.

Shaw, H., & Stice, E. (2016). The implementation of evidence-based eating disorder prevention programs. *Eating Disorders, 24*(1), 71–78. http://dx.doi.org/10.1080/10640266.2015.1113832.

Spiegel, K., Tasali, E., Penev, P., & Cauter, E. Van (2004). Sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Annals of Internal Medicine, 141*(11), 846–850. http://dx.doi.org/10.7326/0003-4819-141-11-200412070-00008.

Stice, E., Presnell, K., Shaw, H., & Rohde, P. (2005). Psychological and behavioral risk factors for obesity onset in adolescent girls: A prospective study. *Journal of Consulting and Clinical Psychology, 73*(2), 195–202. http://dx.doi.org/10.1037/0022-006X.73.2.195.

Stroebe, W., Van Koningsbruggen, G. M., Papies, E. K., & Aarts, H. (2013). Why most dieters fail but some succeed: A goal conflict model of eating behavior. *Psychological Review, 120*(1), 110–138. http://dx.doi.org/10.1037/a0030849.

van der Horst, K. (2012). Overcoming picky eating. Eating enjoyment as a central aspect of children's eating behaviors. *Appetite, 58*, 567–574. http://dx.doi.org/10.1016/j.

appet.2011.12.019.
Versace, F., Kypriotakis, G., Basen-engquist, K., & Schembre, S. M. (2016). Heterogeneity in brain reactivity to pleasant and food cues : evidence of sign-tracking in humans. *Social Cognitive and Affective Neuroscience, 11*(November 2015), 604–611. http://dx.doi.org/10.1093/scan/nsv143.
Versace, F., & Schembre, S. M. (2015). "Obesogenic" oversimplification. *Obesity Reviews, 16*(8), 702–703. http://dx.doi.org/10.1111/obr.12301.
Wardle, J. (1987). Hunger and satiety: A multidimensional assessment of responses to caloric loads. *Physiology and Behavior, 40*(5), 577–582. http://dx.doi.org/10.1016/0031-9384(87)90100-4.
Westermann, S., Rief, W., Euteneuer, F., & Kohlmann, S. (2015). Social exclusion and shame in obesity. *Eating Behaviors, 17*, 74–76. http://dx.doi.org/10.1016/j.eatbeh.2015.01.001.