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Research report

From the Garden of Eden to the land of plenty
Restriction of fruit and sweets intake leads to increased fruit and sweets consumption in children

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ABSTRACT

Overweight is increasing rapidly in children, compelling researchers to seek for determinants of adverse food intake. In a previous experiment it was found that manipulating the restriction of attractive snacks increased the desirability and intake of these snacks. In the present study, we tested whether this paradoxical restricting effect is also seen in relatively less attractive but healthy food, i.e. fruit. Will fruit become more desirable through restriction, and will children eat more forbidden fruit than non-forbidden fruit?

Two groups of young children were forbidden to eat fruits and sweets, respectively, whereas a control group was invited to eat everything. Desire for sweets remained high in the sweets-prohibition condition, whereas it decreased in the fruit-prohibition and no-prohibition conditions. No group differences were found regarding the desire for fruit. With respect to intake, children in both the fruit- and the sweets-prohibition condition consumed more of the formerly forbidden food during a taste session as compared to the no-prohibition condition. In addition, total food intake was higher in the two prohibition conditions than in the no-prohibition condition. These data indicate that the adverse effects of restriction apply to both attractive unhealthy and relatively less attractive but healthy food.

Introduction

Overweight and obesity are becoming alarmingly prevalent in the Western society. In the Netherlands, 46% of all adults are overweight (Body Mass Index (BMI) > 25 kg/m^2; CBS, 2006), whereas over 10% are obese (BMI > 30 kg/m^2; CBS, 2006). In the United States, the figures are even more shocking: one in every three adults is obese (Ogden et al., 2006). Also, overweight and obesity in children have increased to exceptional proportions. At present, one out of seven Dutch children is overweight (van den Hurk et al., 2006). In the United States, about 17% of all children and adolescents are overweight, whereas an additional 16.5% are at risk of becoming overweight (Ogden et al., 2006). Obesity is diagnosed in 3% of Dutch children. As childhood overweight generally tracks into adulthood (Clarke & Lauer, 1993; Serdula et al., 1993; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997), it is of major significance to challenge overweight early in life.

In general, obesity is caused by an imbalance between the intake and the expenditure of energy (Wabitsch, 2000). Current food patterns do not only show substantial increases in snack intake compared to 25 years ago (St-Onge, Keller, & Heymsfield, 2003), they also indicate that children do not consume enough fruit and vegetables. Even though the Dutch National Food Council recommends that children eat at least two portions of fruit a day (Health-Council-of-the-Netherlands, 2002), Dutch children eat less than one portion of fruit (Dutch Food Consumption Survey, 1998). As fruit consumption protects against overweight (McCrory et al., 1999), increasing fruit intake is just as important as decreasing the intake of unhealthy kinds of food.

Parents leave their mark on the development of their children's weight status (see e.g. Birch & Fisher, 1995). They have an important role in stimulating healthy eating behaviour in their children and parental modelling has a consistent influence on the child's eating behaviour (Brown & Ogden, 2004). It was, for example, found that children imitate their parents in both food preferences and food avoidances (Guidetti & Cavazza, 2008). Considering all of this, it seems obvious to keep children away from certain unhealthy kinds of food, and to encourage them to eat healthy food. In addition to being role models for their children and being in charge of purchasing and providing meals, parents may also influence their children's eating patterns by using control techniques. According to Birch et al. (2001) parental control in the

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domain of eating can be subdivided into pressuring the child to eat healthy kinds of food (e.g. fruit and vegetables) and restricting intake of unhealthy, palatable (fatty or sweet) kinds of food. Overcontrolling a child's food intake potentially leads to adverse effects on food preference and intake. It has been hypothesized that parents overcontrolling their children's food intake may interfere with their children's ability to self-regulate their intake. As a result, children would be more responsive to external cues (e.g. the smell and presence of foods) as opposed to internal cues (e.g. hunger and satiety) (Faith, Scanlon, Birch, Francis, & Sherry, 2004; Jansen et al., 2003). In turn, this could lead to disturbed eating behaviours like eating in the absence of hunger, restrained eating and ultimately excess weight gain (Birch & Fisher, 2000; Birch, Fisher, & Krahnstoever Davison, 2003; Robinson, Kiernan, Matheson, & Haydel, 2001).

Researchers have found pressuring to eat healthy kinds of food to be associated with lower fruit and vegetable consumption and picky eating in children (Galloway, Fiorito, Lee, & Birch, 2005). In an experimental design examining the influence of pressure to eat, Galloway, Fiorito, Francis, and Birch (2006) found that normal weight children consumed more soup and made fewer negative comments when they were *not* pressured to eat. Thus, pressuring children to eat indeed appears to result in adverse consequences.

Evidence for the potential negative effects of restriction is largely correlational. Several researchers have found parents' restrictive behaviour to be associated with their children's weight status: the more restriction of food intake, the higher the weight (Birch et al., 2003; Constanzo & Woody, 1984). Although it might seem plausible that restriction by parents could result in disturbed eating behaviour, the alternative could be that parents start restricting the intake of palatable kinds of food as they observe their children becoming heavier. This problem of causality can be solved by manipulating restriction behaviour in an experimental setting. Past research in rats has shown that, even without depriving energy, restricting access to alcohol (Wayner et al., 1972) or an optional high-fat food (Corwin et al., 1998) leads to significant increases in the consumption of the restricted substance when it is subsequently made available. Fisher and Birch (1999) studied the influence of restriction of palatable foods in children. In this study, children participated in eight group snack sessions: four unrestricted sessions, followed by four restricted sessions. The target food was a palatable snack food. The alternative was a food of lower preference. During the unrestricted sessions, both types of food were freely accessible during 15 min. During the restricted sessions, children had only one 5 min period of free access to the restricted food. The results showed that children's behavioural response (requests for the food, attempts to obtain it or comments about liking it) to the palatable snack food was greater during restricted sessions that during unrestricted sessions (Fisher & Birch, 1999).

Jansen, Mulkens, and Jansen (2007) also studied the influence of restriction in children. It was tested whether a prohibition of attractive snacks would lead to an increased desire for that food and overeating at a later moment in time. Children in the experimental group were not allowed to eat red M&M's and red crisps in the first phase of the experiment (but were allowed to eat the yellow versions of these same snacks), whereas children in the control group were allowed to eat from both red and yellow snacks in the first phase. The second phase of the experiment was an 'all you can eat' phase for both groups. Desire for and intake of red food increased in the experimental group, whereas desire and intake of red foods remained constant in the control group. From this study it was concluded that restricting the intake of attractive snacks in children actually has adverse effects on food preference and intake. Moreover, it was found that parental restriction, measured among parents with the restriction scale of the Child Feeding Questionnaire (CFQ; Birch et al., 2001), was associated with snack intake during the taste sessions. Both children of parents reporting either low or high levels of restriction consumed significantly more snacks during the experiment than children of parents reporting a moderate level of restriction.

As restricting the intake of attractive snacks increases the desirability of these snacks (Jansen et al., 2007), it would be useful to examine whether it is also possible to make relatively less attractive kinds of food (e.g. fruit) more desirable by the use of restriction. Therefore, the current study focuses on the effects of restriction of both attractive and less attractive food. In this study we test whether prohibiting either sweets or fruit will result in an increased desire for the forbidden food followed by an increased consumption. Desire for and consumption of the forbidden food is expected to increase after prohibition, regardless of which type of food is forbidden. Further, it is hypothesized that the degree of restriction at home will be associated with overall energy intake during the experiment: the more a child is restricted at home, the more it is expected to consume during the taste sessions.

Method

Participants

Seventy children were recruited from two primary schools in the Netherlands. Participants were told that the experimenter was interested in what kind of tastes children like. The participating children were 5–7 year olds (mean age = 5.57, S.D. = 0.55). In this age group, minimal social desirable behaviour concerning eating was expected. Older children, or adolescents, could possibly experience feelings of shame and guilt to a greater extent than younger children. In addition, children in this age category are able to obey prohibitions (Piaget, 1965). Permission for participation was obtained from the participating schools as well as from the children's parents. Parents were requested not to share information concerning the content of the study with their children. The study was approved by the ethical committee of the Faculty of Psychology, Maastricht University. Cooperating schools received a gift certificate afterwards. Participant characteristics are summarized in Table 1.

Table 1
Age, gender and BMI characteristics of the three conditions

	No-prohibition condition		Fruit-prohibition condition		Sweets-prohibition condition		*F* value	*P* value
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
N	22		25		23			
Age	5.36	0.49	5.72	0.54	5.61	0.58	2.62	NS
Gender (boy/girl)	13/9		16/9		14/9		0.06	NS
BMI percentile	77.15	20.95	60.11	26.28	81.36	23.67	5.38	<0.01

One-way ANOVAs showed no significant differences between conditions regarding age and gender distribution. However, groups differed significantly regarding BMI (Body Mass Index) percentile.

Design

Participants were randomly assigned to one of three conditions: a no-prohibition condition, a fruit-prohibition condition and a sweets-prohibition condition (between subjects factor). The experiment consisted of two phases (within subjects factor); during the first phase the actual manipulation (prohibition yes/no) took place, phase two was an 'all you can eat' phase for all groups. Dependent variables were intake of both fruit and sweets in grams and desire for the prohibited food on a 5-point Likert scale.

Measurements

Fruit and sweets

In this study, banana slices (550 g per bowl) and pineapple pieces (750 g per bowl) were presented as fruits. M&M's chocolates (750 g per bowl) and Haribo® fruitgums (700 g per bowl) represented the sweets category. All four kinds of food were presented to all participants. Participants in the fruit-prohibition condition were prohibited from eating all fruits in phase 1, whereas participants in the sweets-prohibition condition were not allowed to eat the sweets in phase 1. Children in the no-prohibition condition were allowed to eat from all four kinds of food in phase 1.

All kinds of food were presented in identical bowls. Red or green sheets were placed underneath the bowls to indicate whether it was in the forbidden category (red sheet) or the allowed category (green sheet).

Desire to eat, palatability and satiety

To measure the desire to eat a particular kind of food, a 5-point rating scale, ranging from 0 ('I do not want to eat this at all') to 4 ('I want to eat this really bad') was used. Palatability of the food was measured with a 10 cm Visual Analogue Scale (VAS). The left extremity (0) represented 'not palatable at all' and the right extremity (10) represented 'very palatable'. Finally, satiety was measured with a 10 cm VAS (0: 'my tummy is totally empty', 10: 'my tummy is completely full'). Palatability and satiety were measured before phase 1 to assure that the participants from the different conditions did not differ in their palatability ratings and were equally satiated before the experiment started. Desire was assessed both before and after phase 1.

Body Mass Index

Participating children's weight and height were measured once at the end of the session. Participants had their clothes on, coats and shoes off. Weight in kilograms, rounded off to one decimal, was measured by means of a digital scale. Height in centimetres, rounded off to one decimal, was assessed with measuring tape which was applied on the wall. The experimenters had undergone a short training in collecting this kind of information correctly. BMI percentiles were calculated subsequently (Children's BMI-for-age Calculator, USDA/ARS Children's Nutrition Research Center).

Procedure

All children were individually tested. They were picked up from their class rooms one by one and asked to sit down in a quiet room were they were not distracted. The experimenter then introduced herself and told the participant that he/she would have to answer various questions and taste different kinds of food. The actual experiment then began. Current levels of satiety, palatability and desire for all to be presented foods were assessed. Then the first taste session started. During this 5-min taste session, the children were left alone with the food. Four bowls, one for each type of food (banana, pineapple, M&M's and fruitgums) were presented during this phase. All participants had the same four bowls in front of them. Children in the no-prohibition condition were allowed to eat all types of food during this phase. This was underlined by the green sheets underneath all four bowls. Children in the sweets-prohibition condition were instructed not to eat from the M&M's or the fruitgums. This was visualized by the red sheets underneath the bowls filled with sweets. However, they were allowed to eat from the bowls with fruit, indicated by green sheets underneath those bowls. Likewise, children in the fruit-prohibition condition were instructed not to eat from the banana slices or the pineapple pieces. Yet, they were permitted to eat from the bowls filled with sweets. They were left alone, and after 5 min the experimenter returned to take away the food, which was weighed in another room. Levels of desire for the foods were then assessed. Next, in the second phase, which also took 5 min, all participants received the same instruction: they could eat as much as they liked from all four bowls. This was underlined by the green sheets underneath all bowls. The participant was left alone for 5 min. Then the experimenter returned and took the food away, and the bowls were again weighed outside the room. Finally, the child's weight and height were measured. The child then returned to the classroom. Parents received a debriefing letter about the experiment afterwards.

Statistical analyses

One-way ANOVAs on desire, palatability and satiety were performed to preclude group differences at the start of the experiment.

In order to analyse the effects of the restriction-manipulation on desire, difference scores for desire for fruit and desire for sweets were calculated (desire after prohibition phase minus desire at start experiment). To test whether the conditions differed in desire change, a MANOVA was carried out entering difference scores for both desire for fruit and desire for sweets as dependant variables and condition as factor.

To determine the effects of the restriction manipulation on intake in phase 2, another MANOVA was performed (intake of fruit in phase 2 and intake of sweets in phase 2 as dependant variables, group as factor). Finally, Hypothesis 3 was tested by means of linear regression. The 'restriction' scale of the CFQ was entered as a predictor in the regression. The dependent variable was total food intake in kilocalories.

Child Feeding Questionnaire

Along with an informative letter about the study and an informed consent form, parents received the 'restriction' scale of the Dutch Child Feeding Questionnaire (Birch et al., 2001, translated with permission of the authors) to fill in. The CFQ is a measure of parental attitudes, beliefs and practices of child feeding and obesity proneness. The 'restriction' scale of the CFQ comprises eight items on restrictive practices (for instance 'I intentionally keep some foods out of my child's reach'). Every item is scored on a scale from 1 to 5. The higher the score, the more parental restriction is expected to be exerted. The internal consistency of this subscale is good (Cronbach's $\alpha = 0.72$). As yet, the validity of the CFQ is unknown. Nevertheless, a high agreement between parents and children was found (Jansen et al., submitted for publication).

Results

One-way ANOVAs showed no group differences with respect to desire, palatability and satiety ratings before phase 1. However,

Table 2
Control measures, desire and intake of the three conditions

	No-prohibition condition, $N = 22$		Fruit-prohibition condition, $N = 25$		Sweets- prohibition condition, $N = 23$		F value	P value
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Before phase 1								
Desire fruit (0–4)	2.41	1.45	2.52	1.13	2.43	1.24	0.05	<1.0
Desire sweets (0–4)	3.18	1.02	3.50	0.65	3.09	1.24	1.16	<0.4
Palatability fruit (1–10)	5.75	3.12	6.50	2.60	5.67	2.75	0.63	<0.6
Palatability sweets (1–10)	7.80	2.10	8.34	1.57	7.59	2.44	0.86	<0.5
Satiety (0–10)	6.10	2.71	5.68	2.64	6.26	2.16	0.34	<0.8
After phase 1								
Increase in desire fruit	−0.64	1.42	−0.08	0.98	−0.39	1.11	1.34	<0.3
Increase in desire sweets	−0.59	1.75	-1.10^{a}	1.13	-0.04^{b}	0.50	4.45	<0.05*
Phase 2								
Fruit intake (g)	22.77^{a}	28.23	44.72^{b}	45.12	17.09^{a}	18.11	4.74	<0.05*
Sweets intake (g)	22.95^{a}	23.90	27.88^{a}	21.58	43.83^{b}	29.77	4.26	<0.05*
Intake (kcal)	117.20	87.31	153.56	83.68	193.01	121.66	3.32	<0.05*

Means with different subscripts are significantly different from each other.

conditions differed significantly regarding BMI (Body Mass Index) percentile. Therefore, the reported analyses included BMI percentile as a covariate. Means, S.D.s, F- and P values are listed in Table 2. Paired sample t-tests show that participants preferred the taste of sweets over fruit [$t(69) = -4.55$, $p < 0.001$] and displayed a larger desire for sweets as opposed to fruit at the start of the experiment [$t(69) = 4.44$, $p < 0.001$].

Hypothesis 1. Desire for the forbidden food increases during phase 1 in the two prohibition conditions as compared to the no-prohibition condition.

The MANCOVA showed no significant group effect for the course of desire for fruit. However, regarding the course of desire for sweets a significant group effect was found [$F(3, 66) = 3.26$, $p < 0.05$]. Post hoc independent samples t-tests showed that the desire for sweets decreased stronger in the fruit-prohibition group than in the sweets-prohibition group [$t(33.6) = 4.26$, $p < 0.001$].

Hypothesis 2. Children in both prohibition conditions consume more of the formerly forbidden food in phase 2 as compared to the no-prohibition group.

The MANCOVA showed a significant difference between groups with respect to the intake of fruit in phase 2 [$F(3, 66) = 4.73$, $p < 0.05$]. Post hoc independent samples t-tests showed that the fruit-prohibition condition consumed more fruit than the no-prohibition condition [$t(40.9) = 2.02$, $p = 0.05$] and the sweets-prohibition condition [$t(32.1) = 2.83$, $p < 0.01$] as soon as the prohibition was neutralized. Similar results were found regarding the intake of sweets in phase 2: the three groups differed significantly [$F(3, 66) = 3.92$, $p < 0.05$]. Consistent with the expectations, post hoc independent samples t-tests showed that participants in the sweets-prohibition condition consumed more sweets than the no-prohibition condition [$t(43) = 2.59$, $p < 0.05$] and the fruit-prohibition condition [$t(46) = 2.14$, $p < 0.05$] as soon as the prohibition was no longer operative. In addition, not only the intake of the formerly forbidden food was higher, total food intake (in kilocalories, as sweets and fruit differ in energy density) in phase 2 was also higher in the prohibition conditions as opposed to the no-prohibition condition [$F(3, 66) = 3.18$, $p < 0.05$].

Hypothesis 3. Children, whose parents are more restricting at home, consume more kilocalories during the experiment.

The regression analysis showed no significant predicting effect of restriction scores on energy intake ($p = 0.44$, $R^2 = 0.01$). The analysis was then repeated with total sweets intake in grams as dependent variable. Again, no effect was found ($p = 0.28$, $R^2 = 0.02$).

Discussion

The objective of the current study was to examine whether the effects of restricting attractive snacks, as earlier found by Jansen et al. (2007), would also be applicable to relatively less attractive kinds of food. Therefore, 5–7-year-old children participated in a taste experiment in which they were either prohibited from eating fruit, prohibited from eating sweets or not prohibited at all. A second taste session followed, during which the earlier imposed prohibitions were no longer operative; all children could eat as much as they wanted. As predicted, children in both the fruit and the sweet prohibition condition consumed more of the earlier forbidden food during the second taste session as compared to the no-prohibition condition. In addition, total food intake was higher in the two prohibition conditions than in the no-prohibition condition. Thus, the data show that restriction indeed results in higher intake, not only when it concerns attractive, unhealthy food, but also when it concerns relatively less attractive, healthy kinds of food (such as fruit).

The increased intake was accompanied by a lack of a reduction in desire. It was found that the desire to eat sweets decreased in the two conditions that were allowed to eat them, whereas desire for sweets remained constant in the sweets-prohibition group. As for the desire to eat fruit, no differences between groups were found. Nevertheless, children in the fruit-prohibited condition ate more fruit in phase 2. The data suggest that the desire-effects of restricting sweets are stronger than the desire-effects of restricting fruit. With respect to consumption, the results strongly supported our expectations: children in the fruit-prohibition condition consumed more fruit than children in the other two conditions as soon as the prohibition was neutralized. Similar results were found regarding the intake of sweets: participants in the sweets-prohibition condition consumed more sweets than participants in the other two conditions as soon as the prohibition was no longer operative. In addition, not only the intake of the earlier forbidden food was higher, total food intake (in kilocalories) in phase 2 was also higher in both prohibition conditions as opposed to the no-prohibition condition. Thus, from these data it can be concluded that restricting the intake of either attractive or moderately attractive kinds of food leads to more consumption of that food at a later time point. On top of that, the extra intake of the formerly

forbidden food at this later moment is not compensated for by eating less of the other presented kinds of food.

It could be argued that the results can be explained by Sensory Specific Satiety (SSS; Rolls & Rolls, 1996). SSS refers to the 'decrease in pleasantness of a food after it has been eaten to satiety and other food not eaten to satiety remains relatively pleasant'. However, there are some arguments against the SSS explanation in this case. First, all four types of food that were presented have a sweet taste. If the SSS effect was so strong, it would have carried over from the fruit to the sweets and vice versa (Rolls, Rolls, Rowe, & Sweeney, 1981), resulting in a decrease of pleasantness of the prohibited foods as well. Possibly, no results would have been found at all, then. Secondly, the data on intake in phase 2 suggest that children in the prohibition conditions consumed a similar amount of the (during phase 1) alternative food as children in the control condition. If SSS could explain all results, children in the prohibition conditions would have eaten less of the (during phase 1) alternative food in phase 2.

Like previous research indicated, these findings suggest once more that restricting intake could lead to unintentional consequences. Whereas parents may try to tone down their children's preferences for sweet and high-fat foods by restricting them, it could be (among other things) precisely this restriction that makes children want and eat the unhealthy kinds of food even more.

The finding that the effects of restriction may be generalized to fruit (at least with respect to intake) is promising. However, implications of this finding are perhaps confusing. On the one hand, it is hopeful that the consumption of fruit can easily be increased by imposing a prohibition first. On the other hand, it seems quite counter-intuitive to instruct parents to restrict their children's fruit intake. Restricting the intake of fruit might well lead to an increase in subsequent fruit intake, but the current research does not provide any information about what happens to fruit preferences and intake in the long term. The chances are that fruit should be available at home, in order for children to eat it. As pressuring children to eat fruit and vegetables seemed to result in adverse effects (Galloway et al., 2005), it is certainly worthwhile to further examine how fruit consumption in the long term can be realized. Even though the adverse effects of prohibiting sweets were found once more in the current study, it is recommendable to examine the long-term effects of restriction of sweets as well. When the effects of restriction will still be present after a longer period of time, parents should be advised not to restrict sweets intake completely.

In general, more research should be done with regard to educational recommendations for parents. Though the adverse effects of complete restriction suggest dismissing this control technique, giving children complete freedom over their intake does not seem right either. An optimal compromise between controlling and letting go is still groping in the dark.

With respect to our third hypothesis, no appreciable results were found. The CFQ restriction scale could not be correlated to energy intake during the experiment. As the results of earlier research were promising (Jansen et al., in press), the nature of the relationship between the CFQ and intake should be investigated in future research.

A limitation of the current study concerns a methodological issue. Fact is that in the current study, restriction was enforced by a stranger in a school setting. Therefore, the results cannot unthinkingly be generalized to restrictive parental practices at home. Perhaps, parents provide their children with a more thorough explanation of why they cannot eat a particular food. On the other hand, by providing an alternative to the forbidden food, it was attempted to resemble a real life situation as much as possible. Another way of testing the effects of restriction could be to instruct parents to restrict (or not restrict) their child at home and investigate what happens. However, several (important) parameters such as whether the children really leave the forbidden food alone at home and outside their homes cannot be controlled completely then. The strength of the current study lies in the fact that the effects of restriction were manipulated experimentally, which can tell us something about the causal relationship between restriction and eating behaviour.

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