

Substituting Snacks With Strawberries and Sudokus: Does Restraint Matter?

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Objective: Prior research demonstrates that fruit/vegetables and sedentary activities can serve as substitutes for high-calorie snack foods, when the behavioral costs for obtaining snack food increase. The current study investigated if fruit/vegetables are better substitutes for snacks than sedentary activities are and whether individual differences in dietary restraint play a role in how snacks are being substituted. **Design:** Participants ($n = 59$) performed a concurrent schedules task, in which fruit/vegetables, sedentary activities, and snacks were simultaneously available. The response requirement for earning snacks increased per trial. Afterward, dietary restraint was measured. **Main Outcome Measures:** The amount of responses for snacks per trial and the amount of points earned for fruit/vegetables and sedentary activity per trial. **Results:** When snacks are harder to obtain, participants increased working for both fruit/vegetables and sedentary activities. No differences were found for dietary restraint in the way snacks were substituted. However, high-restrained participants worked harder for snack foods than low-restrained participants. **Conclusion:** Fruit/vegetables and sedentary activities are both equally viable substitutes for high-calorie snacks. High-calorie snacks have a higher reinforcing value for highly restrained eaters.

Keywords: dietary restraint, food reinforcement, obesity

The incidence of overweight and obesity is still increasing. Obesity can have many negative health consequences, such as Type 2 diabetes and cardiovascular disease (Visscher & Seidell, 2001). Nowadays, too many people have poor diets, mostly containing low-nutritional, high-energy dense foods. To put a stop to the increase in this obesity epidemic, it is important to alter people's unhealthy eating behaviors to more healthy ones. People should do something else than overly consume high-calorie snack foods, but what effectively substitutes for eating snacks?

Goldfield and Epstein (2002) studied whether fruit, vegetables, and sedentary activities are good substitutes for snack food. By means of a concurrent schedules task, the relative reinforcing value of snack food was measured. The relative reinforcing value of a reinforcer is measured by how hard a participant will work for this reinforcer compared to an alternative reinforcer. The amount of effort someone is prepared to invest in obtaining snack food, therefore, also depends on the available alternative. For instance, when the alternative itself is highly preferred, one will switch almost directly to working for this alternative when obtaining snack food requires increasingly more effort. However, one will be reluctant to switch that rapidly to working for the alternative when the alternative is far less preferred than snack food.

Goldfield and Epstein (2002) gave half of the participants this concurrent schedules task with snack food and fruit/vegetables as choice options, the other half of the participants got the same task, but instead of fruit/vegetables they were offered sedentary activities as the alternative to snacks. This study revealed that snacks were substituted by both fruit/vegetables and sedentary activities when the reinforcement ratio for snacks increased. At face value, these results suggest that fruit/vegetables and sedentary activities are both equally viable substitutes for snacks. Goldfield and Epstein concluded that "the relative reinforcing value of snack foods versus fruits and vegetables is almost identical to the relative reinforcing value of snack foods when compared with sedentary activities" (Goldfield & Epstein, 2002, p. 302), and that "normal-weight participants will shift choice from snack foods to healthy food and nonfood alternatives when access to snack foods is decreased, indicating that healthy food and nonfood alternatives can substitute for snack foods" (Goldfield & Epstein, 2002, p. 302). However, this does not need to be the case. It is conceivable that sedentary activities or fruits are only a viable substitute for snacks when they are the sole available alternative to snacks. In daily life, however, choices rarely comprise a mere two options. According to this line of reasoning, to determine whether sedentary activities and fruit/vegetables are equally good substitutes for snacks requires all three reinforcers being offered simultaneously in a concurrent schedules task to the participant. Johnson, Bickel, and Kirshenbaum (2004) demonstrated the relevance of such a comparison. They tested whether nicotine gum and denicotinized cigarettes are good substitutes for nicotine-containing cigarettes. In this study, they used similar concurrent schedules tasks where the nicotine-containing cigarettes increased in behavioral costs and the substitutes were available at constant behavioral costs. There were

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three phases, one where nicotine gums were concurrently available with the nicotine containing cigarettes, another one where denicotinized cigarettes were concurrently available with the nicotine-containing cigarettes, and yet another one where both nicotine gum and denicotinized cigarettes were concurrently available with the nicotine containing cigarettes. If either substitute was solely available with the nicotine containing cigarettes, the nicotine-containing cigarettes were similarly substituted for the available reinforcer, when behavioral costs for the nicotine-containing cigarettes increased. However, when all three reinforcers were available simultaneously, the nicotine containing cigarettes were almost entirely substituted by the denicotinized cigarettes, not the nicotine gum. Thus, in smokers, denicotinized cigarettes are better substitutes for normal cigarettes than nicotine gum is (Johnson et al., 2004).

Reinforcers do not have to share any characteristics to substitute for one another—a form of substitution termed private/personal substitution (Lancaster, 1966; Lea, Tarpy, & Webly, 1987)—but generally the better the substitute the more features it shares with the product it substitutes (Madden, 2000). Substituting commodities for others that share the same characteristics but are at lower cost is known as *efficiency substitution* (Lancaster, 1966; Lea et al., 1987).

The aim of the current study was to investigate whether fruit/vegetables are better substitutes for snacks than sedentary activities are. This was done by means of a concurrent schedules task, in which there were always three choice options: snacks, fruit/vegetables, and sedentary activities. The response requirement to obtain further snacks was progressively increased during the task, and it was measured at what point during the task the participants would switch to working for any of the two alternatives and if switching to fruit/vegetables would be more prominent than switching to sedentary activities.

In previous research, we found that the relative reinforcing value of snacks differs between individuals (Giesen, Havermans, Nederkoorn, Strafacci, & Jansen, 2009). Participants scoring relatively high on the Restraint Scale (RS; Herman & Polivy, 1980), who were concerned about their weight but were not following any specific diet to lose weight at the time, paradoxically worked harder for access to snack food as compared to unrestrained eaters. For that reason, we again wanted to test whether participants scoring relatively high on the RS work harder for snack foods when even two alternative reinforcers are available. Furthermore, it is conceivable that especially for the high-restrained participants, the fruit/vegetables comprise a better substitute for snack food than sedentary activity does.

First, we tested whether high-restrained eaters work harder for obtaining snack food compared to low-restrained eaters, as found previously (Giesen et al., 2009). Second, we tested whether fruit/vegetables comprise a better substitute for snack food than sedentary activity does and whether this especially is the case for high-restrained eaters.

Method

Participants

Participants were 59 undergraduate students from Maastricht University in the Netherlands of which 39 were female. Students

were invited to take part in an experiment concerning choice behavior in return for course credits. Data from three (female) participants were excluded from analyses, because of technical and procedural errors. This study was approved by the institutional review board of the Faculty of Psychology at Maastricht University. A summary of participant characteristics is given in Table 1.

Procedure and Materials

When invited for participation, participants were asked to eat something three hours before the experiment and to abstain from further eating until participation. Every participant was tested individually between 11 a.m. and 6 p.m. Upon arriving in the laboratory the participant received information on the experimental procedure and signed a consent form. Then the participant sampled four snack food items and four fruit/vegetable items, and they were briefly demonstrated four sedentary activities and rated them accordingly on hedonics (11-points scale: 0 *not at all appealing at the moment* to 10 *highly appealing at the moment*). This was followed by a ranking task in which the participant was asked to rank the 12 different options in order of most appealing at the moment to least appealing at the moment. The food items consisted of bite size portions of cucumber, strawberries, pineapple (Del Monte Foods, San Francisco), and green grapes for the healthy category, and for the snack food category, there were chocolate M&M's (Masterfoods, Veghel), chocolate chip cookies (Van Welzen, Smilde Bakery, Edam), wine gums (Basset's, Cadbury Netherlands, Breda), and paprika flavored chips (Lay's, Smiths Food Group, Utrecht). The activities consisted of reading popular magazines, surfing the Internet, solving Sudoku puzzles, or playing a computer game (Arkanoid; Fujita & Sasabe, 1986). After rating and ranking the 12 different options, subjective hunger was assessed with a 100 mm Visual Analogue Scale (VAS; ranging from 0 *not at all hungry* to 100 *extremely hungry*) and a filler questionnaire about choice behavior was administered. This was done to create some extra time for the experimenter to enter the highest rated snack, the highest rated fruit/vegetable, and the highest rated sedentary activity as choice options for the concurrent schedules task into the computer program.

After these questionnaires, the participant was explained that s/he could earn points for three of the 12 options s/he just evaluated and that the computer would randomly select these three options. In reality, participants always got to play for their highest rated snack, highest rated fruit/vegetable, and highest rated sedentary

Table 1

Means and Standard Deviations of Participant Characteristics: Age, Hunger, Body Mass Index (BMI; kg/m²), Score on Restraint Scale (RS) and Hedonic Ratings for Favorite Snack, Favorite Fruit/Vegetables and Sedentary Activity

	<i>M</i>	<i>SD</i>
Age	21.96	3.13
Hunger (100 mm)	49.50	21.66
BMI	22.76	2.78
RS	10.75	5.02
Hedonics snacks (0–10)	7.16	2.20
Hedonics fruit/vegetables (0–10)	8.54	1.57
Hedonics sedentary activity (0–10)	7.27	2.48

activity. Next, the participant was explained that, in total, s/he would have to earn 100 points by playing a game and that, during the game, s/he could distribute these points across the three options as preferred. The participant was explained beforehand that every 10 points equaled 10 g of the matching food or one minute of time to spend on the sedentary activity and that as the game proceeded it would get harder to earn points for one of the three options. Participants were further explained that after the task they would have to eat the food and spend the minutes on the activity they had earned. This instruction served to limit the probability of socially desirable responding by the participant during the task.

The game consisted of five trials. In every trial, 20 points in total (snack points + fruit/vegetable points + activity points) had to be earned. Each trial comprised of making a series of choices. For each choice, a picture of the high-calorie snack, fruit/vegetable, and sedentary activity was presented on screen and the participant was instructed to press the key corresponding to their choice. Immediately after the key press, participants would receive feedback indicating whether they had earned a point for their choice, or not. In the first trial, the reinforcement schedules for snacks and fruit or vegetables and sedentary activity were all set at FR2 (Fixed Ratio of 2), meaning that after every two responses on the same key a point was earned for the corresponding option. This FR2 reinforcement schedule remained the same for the fruit/vegetable and activity option throughout the task. However, the reinforcement schedule for the high-caloric snack option changed with each trial, from FR2 in the first trial to FR4, FR8, FR16, and FR32 in the fifth and last trial. So, when a participant would want to earn a point for snack food in the last trial, s/he would have to press 32 times on the same response key and, thus, 640 times if s/he would want all the 20 points in this trial for snack food (see also, Giesen et al., 2009; Goldfield & Epstein, 2002; Havermans, Jansen, Giesen, Roefs, & Jansen, 2009; Lappalainen & Epstein, 1990; Raynor & Epstein, 2003; Saelens & Epstein, 1996; Smith & Epstein, 1991).

After the participant finished the task, the RS (Herman & Polivy, 1980) was administered. Then, the earned food was provided and the participant ate the food and spent the time earned on the sedentary activity. Finally, weight and height were measured and the participant was thanked for participating.

Design and Analysis

For the first analysis in which we tested whether restraint status affects how hard someone works for snack food, the dependent variable is the number of responses for snacks in each trial on the concurrent schedules task. Number of responses for snacks were analyzed in a 5 (trial: FR2, FR4, FR8, FR16, FR32) \times "Restraint score" repeated measures Analysis of Covariance (ANCOVA) with trial as within subjects factor and Restraint score as covariate. We decided to take restraint as covariate to minimize the loss of power instead of taking a median split and using it as a between subjects-factor (see Van Breukelen & Van Dijk, 2007).

For the second analysis, to test what reinforcer is a better substitute for snacks, the dependent variable was the number of points earned for fruit/vegetables versus sedentary activities in each trial on the concurrent schedules task. Number of points earned were analyzed in a 2 (option: fruit/vegetable vs. sedentary activity) \times 5 (trial: FR2, FR4, FR8, FR16, FR32) repeated mea-

sures analysis of covariance (ANCOVA). Both option and trial were within subject factors and Restraint score was used as a covariate.

To control for the violation of the assumption of sphericity, Huynh-Feldt epsilon corrections were applied and the corresponding adjusted degrees of freedom are reported for all ANCOVAs. Partial eta squared (η_p^2) is reported as a measure of effect size.

Results

To test for differences in relative reinforcing value of snack food with restraint, as found previously in the study by Giesen et al. (2009), an analysis with trial (FR2, FR4, FR8, FR16, FR32) as the within subject factor and restraint score as covariate was conducted and revealed a significant main effect of trial, $F(2.53, 136.84) = 3.92, p = .014, \eta_p^2 = .068$. This effect was qualified by a significant trial \times restraint score interaction effect, $F(2.53, 136.84) = 3.10, p = .036, \eta_p^2 = .054$. This result indeed shows that participants who are more restrained work harder for snack food (with increasing reinforcement ratio) than participants who are less restrained. To illustrate this finding, Figure 1 shows the mean number of responses for snacks per trial for two groups: high- and low-restrained eaters as based on a median split (median = 11). Further, it is important to note that none of the hedonic ratings for snacks, fruit/vegetables, and sedentary activities correlated significantly with restraint score, all $r_s \leq .094, p_s \geq .489$. This indicates that there were no differences in liking scores for the snacks, fruit/vegetables, and sedentary activities between high- and low-restrained eaters.

To test whether fruit/vegetables are a better substitute for snacks than sedentary activities, particularly for high-restrained eaters, an analysis on points earned for fruit/vegetables versus sedentary activities was performed, with restraint score as a covariate. A main effect for option was found, $F(1, 54) = 6.20, p = .016, \eta_p^2 = .103$. As can be seen in Figure 2, participants earned more points for fruit/vegetables than for sedentary activities. Another main

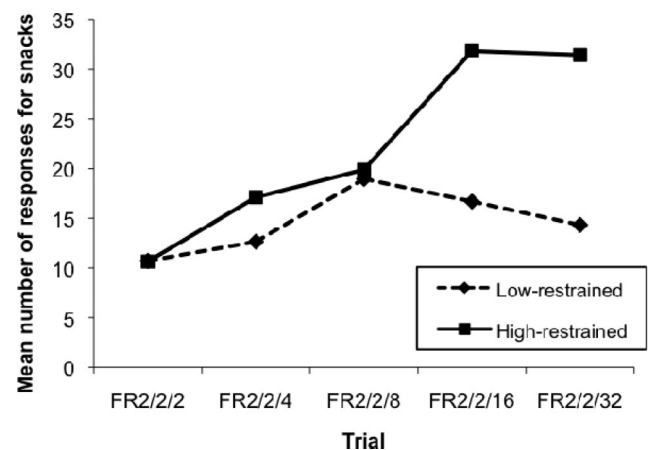


Figure 1. Mean number of responses for snacks per trial for high- and low-restrained eaters, based on a median split (median = 11). FR refers to fixed ratio of reinforcement and the numbers refer to the number of responses required to obtain a single point. Response requirement for fruit/vegetables and sedentary activities stay at FR2, whereas the response requirement for snacks increases from FR2 to FR4, FR8, FR16, and FR32.

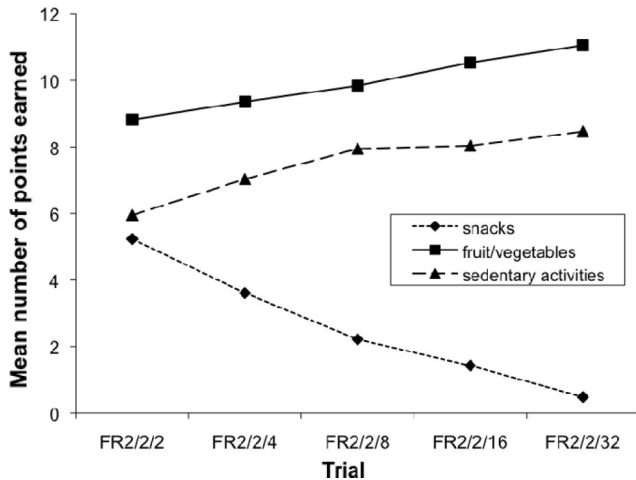


Figure 2. Mean number of points for fruit/vegetables, sedentary activities, and snacks per trial. Reinforcement ratios for both alternatives stay at fixed ratio 2 (FR2), whereas the reinforcement ratio for snacks increases from FR2 to FR4, FR8, FR16, and FR32.

effect was found for trial, $F(3.34, 180.12) = 45.25, p < .001, \eta_p^2 = .456$. Again, as can be inferred from Figure 1, along the trials, points earned for both snack-alternatives increased, meaning that participants did substitute for snacks, which can also be seen in the decrease in points earned for snacks. The hypothesized option \times trial interaction, which would entail that specifically more fruit/vegetables points are earned as the response requirement for snacks increases, was not found, $F(3.25, 175.30) = .309, p = .834, \eta_p^2 = .006$. Also the three-way interaction of option \times trial \times restraint was not significant, $F(3.25, 175.30) = .793, p = .508, \eta_p^2 = .014$.

Discussion

The present pattern of results shows that the more highly restrained participants increased their effort to obtain snack points as the response requirement increased, whereas the less restrained participants did not increase their efforts. In other words, the more restrained, the less one is inclined to substitute the unhealthy snacks. One can argue that snack food has a higher relative reinforcing value in high-restrained eaters.

We further hypothesized that fruit/vegetables are better substitutes for snacks than sedentary activities are, especially for high-restrained eaters. Contrary to our hypothesis, fruit/vegetables and sedentary activities both function as good substitutes for snacks, this was true regardless of restraint status. It appears that high-restrained eaters do not substitute snack food differently from low restrained eaters. Although the number of points earned for both substitutes increased as response requirement for snacks increased, it must be noted that over all trials, more points were earned consistently for fruit/vegetables than for sedentary activities. This difference in responding though is simply explained by the corresponding difference in hedonic scores between fruit/vegetables and sedentary activities (see Table 1). One may wonder whether the hypothesized option \times trial interaction would have occurred if liking for fruit/vegetables and for the sedentary activities had been

equal. Note, though, that specifically the fruit/vegetables option was liked better than the snacks and the activities, which were equally liked. In the present study, the sedentary activity option substituted for the snacks just as well as the highly liked fruit/vegetables did, thus demonstrating that some reinforcers may be less or more attractive than other reinforcers, but this does not imply that it makes these reinforcers less or more effective substitutes for a given reinforcer. Therefore, it is unlikely that we would have found an option \times trial interaction if the fruit/vegetables option was liked as much as the snacks and sedentary activities options were.

In sum, the present pattern of results shows that fruit/vegetables and sedentary activities can both substitute for snack food when behavioral costs for snack food increase. Clearly, both substitutes (i.e., sedentary activity and fruit/vegetables) are reinforcing and can substitute for the reinforcing value of the snack foods, when these latter foods become increasingly difficult to obtain. This finding complements the findings from Goldfield and Epstein (2002); furthermore, we found that the more restrained, the higher the relative reinforcing value of snack food, which also extends our earlier finding (see also Giesen et al., 2009) by showing that high-restrained participants keep working harder for snack food, even when there is more than just one alternative available. One may even argue that the present results underestimate this effect of restraint, as a clear breakpoint was not established for the high-restrained eaters, as can be seen in Figure 1. Would high-restrained eaters also work harder for low-calorie-foods or even sedentary activities? Perhaps, but this is very unlikely, because that would imply that high-restrained eaters are more responsive to virtually any reinforcer that becomes incrementally difficult to obtain.

The concurrent schedules task used in this study is a behavioral economics task derived from animal research. Animals cannot express value into money and, therefore, researchers have animals work for their food. Hence, working for food in this task can be compared to spending money for food. In this case, having to work harder for snacks is similar to increasing the price of snacks (Hursh & Silberberg, 2008). Given the present pattern of results, we may speculate that people will substitute the high-calorie snacks for healthier alternatives with the introduction of a so-called fat-tax. A fat-tax refers to the policy of increasing the price of unhealthy fattening foods to curb the increasing prevalence of obesity (see, e.g., Caraher & Cowburn, 2005). The present results, however, also suggest that with a price increase of snacks only the relatively low-restrained eaters will switch to "paying" for healthier alternatives. One may wonder whether this is a desired effect, as most studies show that especially high-restrained eaters are at risk for developing overweight or obesity (Drapeau, Provencher, Lemieux, & Despres, 2003; Klesges, Isbell, & Klesges, 1992; Lowe et al., 2006; Stice, Cameron, Killen, Hayward, & Taylor, 1999; Stice, Presnell, Shaw, & Rohde, 2005). Of course, this study did not directly test the effect of a fat-tax. The snacks were made more expensive, but this was done by means of an increase in behavioral rather than monetary costs and the choice of substitutes for the snacks was atypical for environments in which a pricing strategy such as a fat-tax would be implemented (such as a restaurant, cafeteria, or supermarket). Nonetheless, we feel that the present results warrant further investigation of the potentially limited efficacy of the introduction of a fat-tax.

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